# AVIONICS GPB CONTROL SYSTEM ANALYSIS FINAL REPORT

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### A STUDY OF THE CRYOGENIC/SUPERFLUID HELIUM INTERACTION WITH THE GPB SPACECRAFT SIMULATION AND ANALYSIS

#### 1.0 INTRODUCTION:

Gravity Probe B is a Satellite being developed by Lockheed/Martin under NASA contract through MSFC and managed by Stanford University. The goal of the satellite experiment is to test the accuracy of drift predictions made using Einstein's General Theory of Relativity. The drift in the direction of the spin axes of 4 highly precise quartz spherical gyroscopes induced by motion in the earth's gravitational field will be measured over a year's duration with the known, non-relativistic effects removed. The expected angles of drift for a one year period are approximately 6.6 arcsec for drift in the orbit plane called geodetic drift and 0.033 arcsec of drift normal to the orbit plane called frame dragging. The aerodynamic drag force on the GPB Satellite is compensated by a translation control system. It is pointed at a guide star and maintained in spin at a rate to be selected in the range 0.1-1 rpm. The purpose of our task is to update the TREETOPS GPB spacecraft simulation and to assist MSFC in assessing the affect of Helium slosh dynamics on spacecraft pointing performance.

The bd Systems Control Dynamics Division Gravity Probe B (GPB) simulation was originally constructed as a part of Control Dynamics support to Fairchild Space in their contracted Phase B Study of GPB for Stanford and NASA. It was built using the multi-body simulation program called TREETOPS. This effort lasted through the late 80's and into the early 90's. The study was completed and Phase C-D downselections were made between the Phase B competitors Lockheed and Fairchild. Lockheed (now Lockheed-Martin) was the winner. In the mid 90's, bd Systems was asked to update the GP-B simulation to provide support to NASA/MSFC in the performance of flexible body and slosh dynamics investigations of the Lockheed-Martin (L-M) configuration. This update consisted of mass and geometry properties and a change from the Fairchild 12 thruster configuration to the L-M 16 thruster setup. Additionally, the control system design was also changed to match the L-M design. Besides an update to the GP-B model an update to the version of TREETOPS being used to the double precision Version 10 was also made. Version 9 had been in use. This had also been double precision but was a special version done for us only. The GPB attitude and translation controllers were implemented in a special TREETOPS user controller written for GPB. Gravity gradient torques, forces and cryogenic disturbances were implemented through the user controller. Orbital dynamics were implemented through the nearly circular orbit perturbation equations built into TREETOPS. Control Dynamics added an aerodynamic drag force and torque model capable of accepting the aerodynamic coefficients supplied by NASA/MSFC. This model was used to perform the required analysis and published a report on the results. Some preliminary slosh analyses were performed using a 4 spring-mass model in which the springs and masses were adjusted to match expected frequencies and masses of GPB slosh. A Computational Fluid Dynamics (CFD) model of helium slosh was being prepared by UAH for MSFC. The plan was to adjust masses and frequencies of the GPB simulation to match these results when they were available. However, these results were never available and the studies were never done. The next phase of activity for the GPB simulation was to generate a full year long simulated science data stream including representative outputs for four science gyro

Superconducting Quantum Interference Devices (SQUIDs). Each gyro has a single axis of outputs with two in the x-z plane and two in the y-z plane.

Recently, we have been asked to support the MSFC GPB helium slosh studies continuing efforts. We have chosen to revive our GPB TREETOPS simulation. Our choice was to update the TREETOPS simulation to our enhanced Version 10. Numerous enhancements have been made to Version 10. The following is a summary list of these enhancements:

- a. Addition of a general gravity module along with a fully dynamic orbit including gravity gradient moments as an alternative to the nearly circular orbit perturbation equations logic. This also included definition of an inertial frame related to either B1950 or J2000 Vernal **Equinox**
- b. Solar Pressure Model, which takes input in the form of reflecting surfaces through an auxiliary file
- c. Fix for restart capability
- d. Fix for Sandia Integration
- e. RK78 Integration added
- f. Addition of surface contact force model with contact surfaces input through auxiliary file.
- g. Addition of air/water drag and static pressure force model with drag and static pressure surfaces input through auxiliary file.
- h. Completion of function generator definitions to include derivatives and integrals
- Addition of user defined, piece-wise linear function with auto-computed derivative and integral
- User defined, piecewise-linear spring with breakaway value
- k. Addition of non-linear controller element, a product junction analogous to a summing junction
- 1. Additional sensors and actuators defined including sensors defined for output only
- m. Redimensioning/resizing for more bodies, sensors, etc.
- n. Treeset modified to accommodate most (but not all) additions
- o. Additional and more descriptive error messages to help diagnose gimbal lock and topology problems

This task is for the purpose of using our previously developed GPB simulation to investigate the potential of the relatively large amount of liquid helium on board the spacecraft to adversely affect the fine pointing performance of the system by sloshing interactions. Complicating this investigation is the superfluid behavior exhibited by cryogenic helium IV. Lockheed-Martin's investigations had concuded that analytically, instability was not going to be a problem. This resumed effort is to take results from CFD simulations of a helium-like fluid in a rotating dewar to help calibrate the frequencies present in a springmass model to be built-into the TREETOPS GPB simulation. The original CFD investigation was never completed due to the illness and ultimate death of the investigator.

The NASA/MSFC CFD study was expanded to include contractor support. A new CFD analysis is being performed by The Aerospace Corporation in parallel with the MSFC study. The plan for the ultimate use of the GPB simulation is to employ the CFD simulations of a rotating dewar in a manner like a structural test and develop a modal model of the fluid. The modes and frequencies of these measurements can be used to build the flexible body model required by TREETOPS. Alternately, Dr. Howard Snyder at the University of Colorado is taking an analytical approach. He computes the solution to the Navier-Stokes

equation in cylindrical coordinates for a spinning dewar with the geometry of the GPB Spacecraft. He next computes system transfer functions from this approach. The transfer functions are then be added to the TREETOPS GPB simulation producing an alternate approach. Sensor models in TREETOPS of angular accelerometers provide the inputs to the transfer functions and actuator models provide the force and torque outputs upon the spacecraft.

#### 2.0 Review of Work Accomplished During the Study:

In June, the work on this task was kicked off with a meeting at NASA/MSFC. Technical efforts were focused on reactivating and updating our Treetops (TT) simulation of the GPB spacecraft. The TT GPB simulation had previously been used to generate a stream of simulated science data in the format and order expected from the flight. A full year's worth of simulated science data. That simulation was a rigid body model. The TT model of GPB used for that work was reestablished and brought to a running condition. The previous helium slosh model development was completed with a primitive spring/mass model. The previous GPB input files have been converted to the current Treetops format. Additional modifications and inputs are required to convert to use of the fully dynamic orbit option. These changes were nearly completed in June. One of the items required is the location of the guide star. Presently, we are assuming the guide star is Rigel and its position is right ascension 78.025° and declination –8.25°. This position was obtained from Burnham's Celestial Handbook and is probably out of date now. We will update this position when more current information is obtained.

During the month of July, the Treetops GPB model updating was continued. New GPB mass properties received from Lockheed/Martin through MSFC were input along with updated control gains. The previous Treetops model was built largely around user defined controllers. The updated version was converted to the fully dynamic orbit from the perturbed circular orbit used previously. It was also converted to use of the ECI frame as the inertial reference from the previous Treetops defined spacecraft inertial frame. This has complicated the initialization of the model but is a more realistic representation of the dynamics. The updating of the Treetops GPB model was also a good opportunity to refamiliarize with the spacecraft system and start the other activity of assisting MSFC and Professor Howard Snyder/University of Colorado in developing a model for the Helium slosh in the helium dewar. In addition, we updated the aerodynamic force & moments model. This helped refresh us of the special considerations associated with the signs and coordinate directions associated with aerodynamic models.

In August, the TREETOPS GPB model updating was completed, bringing the mass properties and control gains to currently defined values provided by MSFC. The updated GPB model uses built-in gravity gradient torque disturbance models whereas, the previous earlier model used subroutines in the user defined controller to add in gravity gradient torque.

The efforts expended in updating the GPB model were useful in restoring our insights and understanding of the GPB operation and dynamic model. This helped us advise MSFC and their helium slosh dynamics modeling contractors Aerospace Corporation and University of Colorado on GPB spacecraft dynamic model and its control system. We refreshed our understanding of the aerodynamic force and torque model, its coordinate system and the assumptions going into it. Some questions remain from our review:

1. How does the aero coordinate system relate to the GPB body system, 2. Are the aero coefficients significantly affected by changing altitudes from 400 to 640 km? We assumed based on earlier aero data that the transformation from aero to GPB body frame is given by [BA] = eul3[135°] eul2[90°]

In late September, bd Systems Control Dynamics Principal Investigator experienced medical problems which caused him to be sidelined unable to work for over a month. Part-time efforts resumed in November with the definition of a random excitation definition function for each of the six input degrees of freedom. This was provided to NASA/MSFC and by them passed on to the other study contractors. This was a set of time functions defined from the input spectra. This input spectrum was flat to a maximum frequency of 1 Hertz and zero beyond. The CFD model was to be excited with this set of random functions and the results were to be processed as a structural dynamics model to determine a set of modes, frequencies and modal gains. These would be provided to define the characteristics for the helium dewar to go into TT. MSFC was to process the output and provide us with the results. However, processing of the results proved to be much harder than expected. This was unexpected initially but later was found to be due to the extremely low damping of the fluid.

Work resumed in earnest in December with formulation of an alternate approach to the spring mass model. This approach was based on the premise that the GPB helium fluid in the dewar is very quiet. It essentially behaves like a solid. In any event, at the microscopic level, it behaves like a very soft solid jello-like material. We decided we could capture the mass properties and the modal behavior by treating it as a solid with a very low E (Young's modulus). The fluid density is known and the material is assumed to fill the dewar with a cylindrical hole down the middle along the symmetry axis. The diameter of the hole is determined by volume of fluid which makes up the mass appropriate to the specified fill level. The structural model is built up with Nastran and is reduced according to which modes are most excitable. The spinning nature of the GPB requires the inclusion of certain mass integrals normally not needed in the non-spinning case. The usual structural model is based on a small displacements assumption and a linearized model. Here, the translations and z rotations are not small and terms which are 2nd order in spin and 1st order in structural deformation are required to be retained. Treetops is equipped to do this as an option in the structural model if the required modal mass integrals can be provided. However, the present form of TREEFLEX has calculated zeros and we are certain at least some of the integrals should not be zero. This is apparently because of the use of generalized degrees of freedom rather that physical, i.e. modal variables rather than nodes except for the single node required to couple to the spacecraft. We still believe the model can be instructive and is useful but with zeros for modal integrals, we do not get the splitting in modal frequencies and centrifugal loading and consequent increase in frequencies with spin.

We have changed the GP-B simulation from the nearly circular orbit perturbation model to use of the general gravity and fully dynamic orbit. Also, we have incorporated the built-in gravity gradient torque model and the aerodynamic model. Since TREETOPS still does not contain a built-in spacecraft induced magnetic moment module, we are using the continuous user controller to model this. The gravity gradient and aero disturbances are now being generated automatically as part of the TREETOPS environment models. The corresponding feed forward modules for these and the cryogenic disturbances are being generated as part of the user defined discrete controller module in TREETOPS. Auxiliary files GAINS.INP, THRUSTERS.INP, and ERRORS.INP provide the control gains, the thruster mounting matrix, and the noise, quantization values and saturation limits. The model definition file, the so-called – int file defines the properties of the GP-B model and is included as appendix A at the end of this memorandum. The fortran source file for the user discrete controller and the user continuous controller is included as appendix B at the end of this memorandum. The auxiliary files named above are included in

appendices C, D, and E. The aerodynamic coefficients are defined by the file NEWTTAE.DAT. This file is included in appendix F.

# 3.0 <u>RESULTS AND CONCLUSIONS OF ANALYSIS OF GPB CONTROL SYSTEM PERFORMANCE:</u>

The GP-B simulation as presently devised according to the definition files contained in appendices A-F has been run to produce the following output files. The first plot shown below in figure 1 is a plot of the orbit angle from the ascending node to the position in orbit at time t. This orbit angle is calculated from other simulation data and is periodically reset in order to be maintained in the range from -180 to 180°. An unwrapped variation on this orbit angle is used in place of time as the abscissa for the remaining plots. It is unwrapped to be single valued.

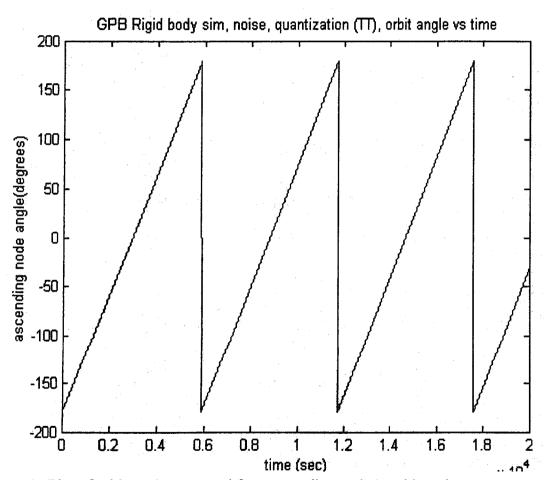


Figure 1. Plot of orbit angle measured from ascending node in orbit at time t.

angle. These orbit conditions were determined by making minor adjustments in the initial orbit velocity until the variations in altitude around the orbit were nominally small. No active control of orbital properties is being applied. The translation control compensates for the drag but does not circularize the orbit.

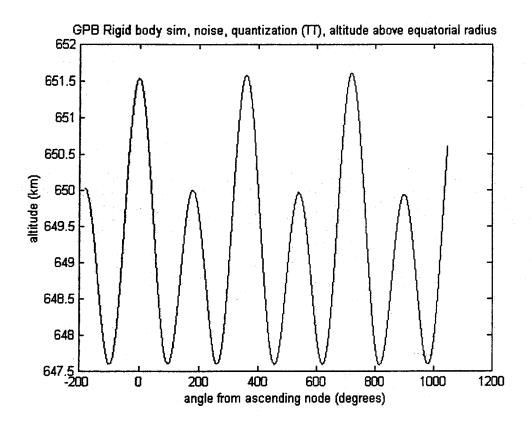


Figure 2. Plot of orbital altitude above equatorial radius vs angle from first ascending node.

The spacecraft is controlled in attitude to point the line of sight of the science telescope at the guide star which for this simulation is modeled as the star Rigel (RA = 78.025°, Dec = -8.25°). Since the GP-B simulation was defined, a new guide star has been designated. This new guide star has not yet been installed at the guide star in the TREETOPS simulation. The new guide star is the star IM Peg, HR 8703 (RA = 343.2592°, Dec = 16.8411°). The position is as specified in the Bright Star Catalog. Since this star is considerably dimmer than Rigel, it is expected that greater noise will attend this change in guide star. No new noise values have been provided as yet. The effect of this change on the performance if any has not yet been assessed

The line of sight pointing errors are plotted in figure 3 in milli-arcseconds. The guide star valid and guide star invalid modes in the science data-taking phase of GP-B operations are evident in the pointing error behavior shown in this figure. During guide star valid operation, the guide star is visible and its output data is available for use in the feedback control. The star apparent position is perturbed by the velocity aberration which results from the finite speed of light and the variation in direction of orbital velocity. This results in an approximately sinusoidal variation in pointing direction to the guide star taking place at orbital frequency. There is also an annual component to this variation as the earth-moon system orbits the sun and carries the GP-B spacecraft (along with all of us) with it.

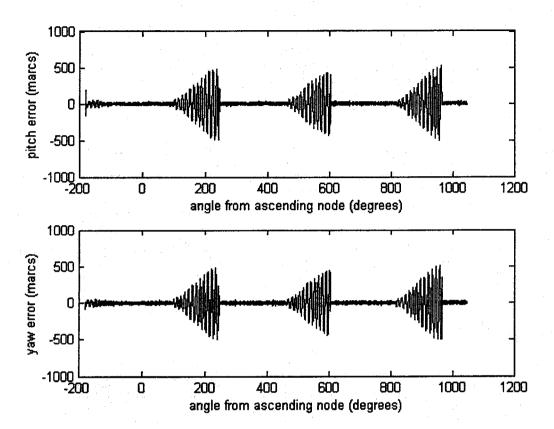


Figure 3. Science telescope pitch and yaw pointing errors vs orbit angle from first ascending node.

The simulation which generated these results was based on rigid body (no flex and no slosh) dynamics but included sensor and thruster noise and quantization. The simulated vehicle spin rate was 0.3 RPM. The simulated altitude is 650 km and the gravity is modeled through j4. As stated previously, velocity aberration is modeled and feed forward for this effect is included in the control. Gravity gradient, cryogenic and aerodynamic forces and torques are also included as part of the environmental disturbances but have not been included as part of the feed forward compensation. The proof mass has been used as the drag free sensor. This needs to be updated to science gyro number 1 or other science gyro if specified. It is presently understood that a separate proof mass is no longer being planned. This is easily changed as new information becomes available. The simulated mass properties used for this run are based on beginning of life conditions. Also, helium mass and moment of inertia contributions are included in the rigid body properties. Additionally, product of inertia terms are assumed to include a negative sign in their definitions so that they can be used directly in the moment of inertia matrix elements in the TREETOPS -.INT file. It has been determined since this run was completed that the products of inertia specified in the mass properties memorandum use the positive integral definition and must therefore be

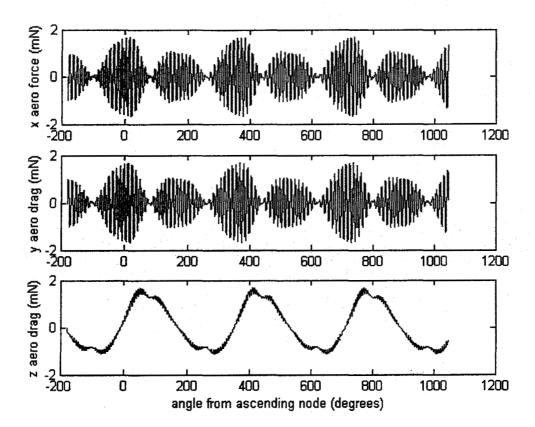


Figure 4. Aerodynamic drag forces expressed in spacecraft body frame vs orbit angle from first ascending node.

reversed before use in TREETOPS. The values are small so that the effect of the change is not expected to be large but will be made and used in all future simulations. Figure 4 shows the aerodynamic drag force calculated by TREETOPS and expressed in the body coordinate frame.

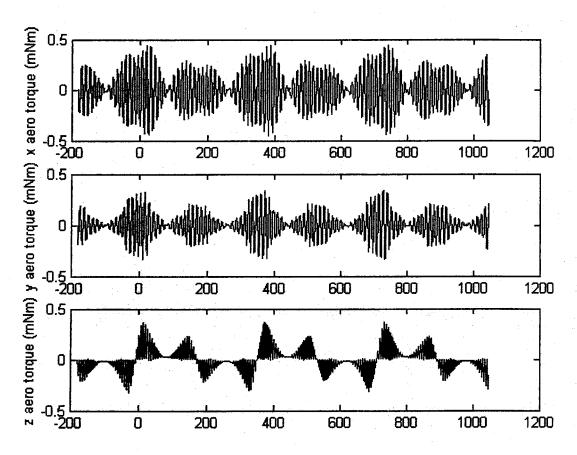


Figure 5. Aerodynamic drag torques expressed in spacecraft body frame vs orbit angle from first ascending node.

The present TREETOPS GP-B simulation calculates a total gravitational force on the spacecraft and on each of the science gyros and the proof mass. The gravity gradient force must therefore be calculated using the proof mass as a reference. The calculated gravity gradient force is therefore calculated using the proof mass position and subtracting the gravity force on the proof mass scaled by the ratio of spacecraft-to-proof mass masses. This result is plotted in figure 6. The gravity gradient force is the primary disturbance which is counteracted by the helium thrusters as well as the aerodynamic force. By the action of the translation control system, the spacecraft is forced to follow the drag free orbit of the proof mass. This force is proportional to the vector distance of the spacecraft center of mass from the center of the proof mass cavity.

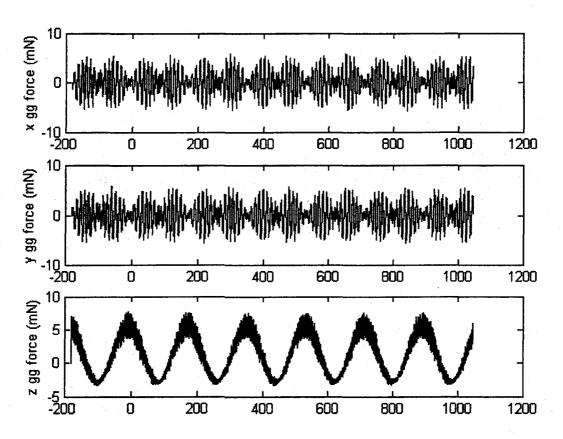


Figure 6. Calculated gravity gradient force vs orbit angle from first ascending node.

The gravity gradient torque is computed about the body origin in TREETOPS. The result is output and plotted below. The output forces and moments from TREETOPS simulations are produced by calculation of constraints where constraints are defined or where degrees of freedom at a hinge are locked. To output forces and moments where constraints are not defined, a force-moment sensor is defined and assigned to the appropriate body and node numbers. The action of the force-moment sensor is to sum all external forces and moments which are applied to the body, at the node where the sensor is located. These force and moment components are expressed in the inertial coordinate frame. The moments are computed relative to the origin of the coordinate system of the body on which the sensor is defined. Aerodynamic forces and moments are referenced to a center of pressure which is assigned to a body node for TREETOPS purposes. This is node 13 on body 1 of the GP-B model. Gravity Forces and moments are referred to the body center of mass which is located at node 1 on each body of a TREETOPS model. Cryogenic moments are assigned to magnetic moment actuators which are located on body 1, node 2. A

force-moment sensor located at node 2 collects this information for output. A post process uses body 1 quaternions to transform force and moment components into the body 1 coordinate frame.

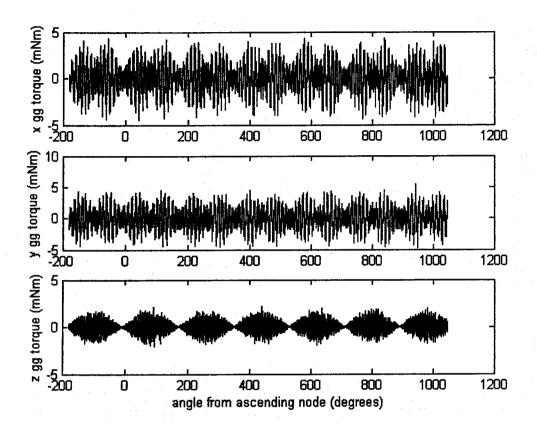


Figure 7. Calculated gravity gradient torque vs orbit angle from first ascending node.

Magnetic field components are determined for each body that has a magnetic moment actuator located on it. A magnetic field sensor (magnetometer) gathers this information for use in a control system or for output. An atmospheric density sensor (densitometer) collects aerodynamic density information, also for output. The figure below shows the magnetic field

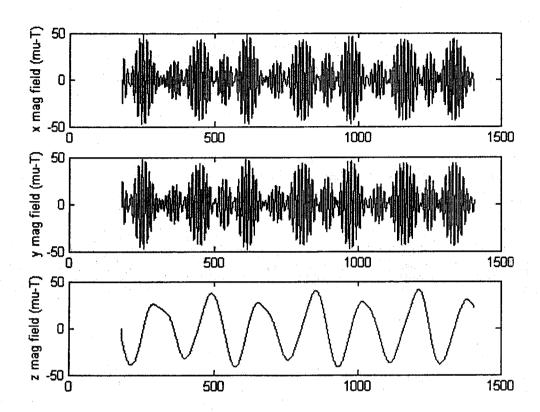


Figure 8. GP-B spacecraft magnetic flux density (micro-Tesla) field components expressed in body coordinates.

The aerodynamic forces and moments are directly proportional to the atmospheric density. The density is calculated using the TREETOPS Jacchia atmosphere model. Figure 9 in the following shows the density calculated at each point in the GP-B orbit.

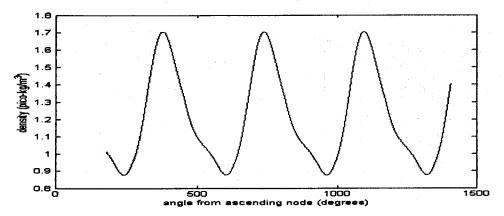


Figure 9. Atmospheric density expressed in pico-kg/m³ i.e.  $10^{-12}$  kg/m³ at GP-B spacecraft location vs orbit angle from first ascending node.

The magnetic field coefficients are slowly time varying and the atmospheric model also includes date and time dependent information as well as information that depends on solar activity which varies with sunspot activity and position. For these reasons a date and time must be selected for the start of the simulation. The reference time chosen for the above simulation run is Greenwich noon on June 21, 2003. The solar activity parameters used by the atmosphere model are solar flux F10 number = 230, 81 day average F10B = 230, geomagnetic index GEAP = 400. These numbers have not been adjusted to reflect current sunspot activity.

#### 4.0 TREETOPS UPDATE AND DEVELOPMENT OF THE HELIUM SLOSH MODEL:

In January and later, techniques were developed for incorporating the helium slosh dynamics into the TREETOPS model using the transfer function approach and the flexible structure body model which is a generalization of the spring/mass model. Construction of a model from the CFD codes continued to elude us. So we concentrated on the transfer function approach. In this, the Navier-Stokes equations for the liquid helium was reduced to Laplaces equation and since the geometry possesses cylindrical symmetry, it is expressed in cylindrical coordinates. This is then solved by the method of separation of variables and development of a superposition of eigenfunctions which are the continuous domain equivalent of modes. The solutions are determined as an expansion in terms of Bessel functions of radius, trigonometric functions of the azimuth variable and hyberbolic functions of the lengthwise variable. We shall not go further into this approach which is being developed and expounded upon by Dr. Howard Snyder of the University of Colorado. This approach leads to a set of transfer functions which can then be incorporated into TREETOPS. During the period from December through the present time the transfer function approach and the flexible body approach were implemented. Also, the guide star was changed from Rigel to IM Pegasus. Change in guide stars will change noise characteristics in the signal from the science telescopes but presumably, that has already been assessed and will not be treated here. The noise data being used in the model has not changed from the Rigel values since no new data was available. Also, no definition was available to us of the feed forward compensation for velocity aberration, that feature as well

as the other feed forward compensations was turned off. Appendix F contains the new model definition file for the transfer function model. This consists of the file called IMPEG\_GPB\_TF.INT and also an auxiliary file called XFERFN.DAT. The auxiliary file allows us to define values for the transfer function polynomials to more digits of accuracy which is critical to properly capturing the extremely small damping of the modes. Appendix G contains the corresponding model definition file for the structural flexibility, spring/damper model. There is also a second file to define the flexible structure but that is too big to be included here. It will be provided elsewhere in electronic form. The performance of these updated models which include the effects of slosh dynamics at 0.3 RPM are shown in the following. First, figure 10 shows a 20,000 second response with the present version of the transfer firection approach.

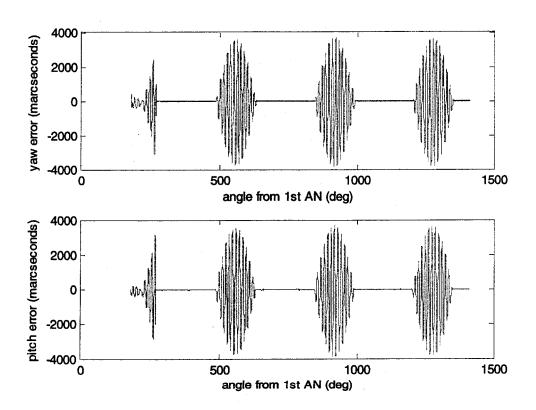


Figure 10. Pitch and yaw errors for slosh transfer function approach plotted versus orbit angle from first ascending node.

As can be seen with figure 10, the is no apparent growth amplitude growth as would be expected if there were a significant response to the slosh dynamics transfer functions. This is not conclusive however, sensitivities need to be looked at and also, the effects of more transfer functions. Reinforcing this result is the flexible structure slosh model. These are shown in figure 11 below:

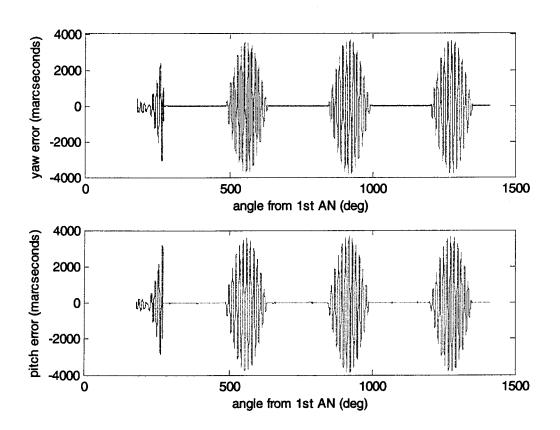


Figure 11. Pitch and yaw errors for flexible body model slosh dynamics plotted against orbit angle from first AN (deg).

#### 5.0 MODEL REACTIVATION AND UPDATE SUMMARY AND CONCLUSIONS:

The bd Systems TREETOPS based simulation of the GP-B spacecraft on orbit in science data taking mode has been successfully updated to the present bd Systems version of TREETOPS called Version 10X. The modifications and additions incorporated into Version 10X from Version 10 were summarized in the introduction. Biggest changes have consisted of conversion to a fully dynamic orbit from a perturbation model, switchover to the generic gravity gradient torque models, an updated version of the sensor model for a star trackers, a local vertical local horizontal sensor, update of the aerodynamic forces and torque model including a detailed review of the implementation of the aero model with an re-assessment of the definition of the aero disturbance frame to assure both our own proper understanding as well as a proper understanding to provide to the Aerospace Corporation Computational Fluid Dynamics GPB spacecraft

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Dynamics model. We have also updated the GPB Dynaic model to include 2 versions, a transfer function version and a flexible body version. The transfer function is currently only partially defined because only two of the maximum of 36 possible functions have been defined. Those have been implemented and to date, have not shown any tendency toward instability over a 20,000 second simulated period. The flexible body model has been implemented but is currently using only a partial set of modal mass integrals. Likewise, it also does not show any tendencies toward instability over the same 20,000 second period. Greater lengths of time should be looked at and more transfer functions included with a study of parameter variations to be expected from these models.

# Appendix A

# GP-B Simulation Definition File GPB.INT

#### TREETOPS REV 10X 1/10/02

#### SIM CONTROL

| SI | 0 Title                                                           | GPB MODEL FOR 2002 |
|----|-------------------------------------------------------------------|--------------------|
| SI | 0 Simulation stop time                                            | 20000              |
| SI | 0 Plot data interval                                              | 2                  |
| SI | 0 Integration type (R,S or U)                                     | R                  |
| SI | 0 Step size (sec)                                                 | 0.10               |
| SI | O Sandia integration absolute and relative error                  |                    |
| SI | 0 RK78 ODE solver absolute error and first step size              |                    |
| SI | 0 Linearization option (L,Z or N)                                 | N                  |
| SI | 0 Restart option (Y/N)                                            | N                  |
| SI | 0 Contact force computation option (Y/N)                          | N                  |
| SI | 0 Constraint force computation option (Y/N)                       | N                  |
| SI | <pre>0 Small angle speedup option (All, Bypass, First, Nth)</pre> | A                  |
| SI | 0 Mass matrix speedup option (All, Bypass, First, Nth)            | A                  |
| SI | <pre>0 Non-Linear speedup option (All, Bypass, First, Nth)</pre>  | A                  |
| SI | O Constraint speedup option (All, Bypass, First, Nth)             | A                  |
| SI | 0 Constraint stabilization option (Y/N)                           | N                  |
| SI | 0 Stabilization epsilon                                           |                    |

#### GENGRAV

| GG | 18 | Gravity, earth sphere/nonsphere/user (S/N/U)? | N         |
|----|----|-----------------------------------------------|-----------|
| GG | 1  | Input gravity constants: GME, ERAD, EMASS     |           |
| GG | 1  | Spherical or Nonspherical (S/N)?              |           |
| GG | 1  | Gravity Potential Harmonics J2, J3, J4        |           |
| GG | 18 | English (ft-slug-s) or metric (m-kg-s) (E/M)? | M         |
| GG | 18 | Day, Month, Year,                             | 21 6 2003 |
| GG | 18 | GMT & sim time 0 (minutes past midnight,      | 720       |
| GG | 18 | Solar Pressure forces Y/N?                    | N         |
| GG | 18 | Input new data for aero model? (Y/N)          | Y         |
| GG | 18 | Solar flux F10 for aero model                 | 230       |
| GG | 18 | Solar flux, 81 day average F10B               | 230       |
| GG | 18 | Geomagnetic index, GEAP                       | 400       |
|    |    |                                               |           |

#### BODY

| во | 1 Body ID number                                     | 1                    |
|----|------------------------------------------------------|----------------------|
| во | 1 Type (Rigid, Flexible, NASTRAN)                    | R                    |
| BO | 1 Number of modes                                    |                      |
| BO | 1 Modal calculation option (0, 1 or 2)               |                      |
| BO | 1 Foreshortening Option (Y/N)                        |                      |
| BO | 1 Model reduction method (NO,MS,MC,CC,QM,CV)         |                      |
| BO | 1 NASTRAN data file FORTRAN unit number (40 - 60)    |                      |
| BO | 1 Number of augmented nodes (0 if none)              |                      |
| во | 1 Damping matrix option (NS,CD,HL,SD)                |                      |
| во | 1 Constant damping ratio                             |                      |
| BO | 1 Low frequency, High frequency ratios               |                      |
| BO | 1 Mode ID number, damping ratio                      |                      |
| BO | 1 Conversion factors: Length, Mass, Force            |                      |
| BO | 1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) | 1                    |
| BO | 1 Moments of inertia (kg-m2) Ixx, Iyy, Izz           | 5230.2 5147.5 3693.4 |
| во | 1 Products of inertia (kg-m2) Ixy,Ixz,Iyz            | 19.3 -6 0            |
| BO | 1 Mass (kg)                                          | 3182.8               |

```
1 Number of Nodes
                                                                         1 0 -0.0002 0.8647
     1 Node ID, Node coord. (meters) x,y,z
     1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                         2 0 -0.0002 0.8647
                                                                         3 0 1.0467 0.6380
     1 Node ID, Node coord. (meters) x,y,z
                                                                         4 0 0 0.10033
     1 Node ID, Node coord. (meters) x,y,z
                                                                         5 -1.19 0 2.51
     1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                         6 1.19 0 2.51
                                                                         7 -1.19 0 -1.9
     1 Node ID, Node coord. (meters) x,y,z
                                                                         8 1.19 0 -1.9
     1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                         9 0 0 -.10033
 BO
                                                                         10 0 0 -.18283
 BO
     1 Node ID, Node coord. (meters) x,y,z
                                                                         11 0 0 -.26533
                                                                         12 0 0 -.34783
     1 Node ID, Node coord. (meters) x,y,z
      1 Node ID, Node coord. (meters) x,y,z
                                                                         13 0 0 0.10937
     1 Node ID, Node structual joint ID
                                                                         2
     2 Body ID number
 BO
     2 Type (Rigid, Flexible, NASTRAN)
                                                                         R
 BO
     2 Number of modes
 BO
     2 Modal calculation option (0, 1 or 2)
      2 Foreshortening Option (Y/N)
     2 Model reduction method (NO, MS, MC, CC, QM, CV)
     2 NASTRAN data file FORTRAN unit number (40 - 60)
     2 Number of augmented nodes (0 if none)
 BO
      2 Damping matrix option (NS,CD,HL,SD)
 BO
     2 Constant damping ratio
BO
     2 Low frequency, High frequency ratios
     2 Mode ID number, damping ratio
 во
BO
     2 Conversion factors: Length, Mass, Force
     2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                          .00001 .00001 .00001
     2 Moments of inertia (kg-m2) Ixx, Iyy, Izz
BO
      2 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                         0 0 0
 BO
     2 Mass (kg)
                                                                         .076
BO
     2 Number of Nodes
                                                                         1
                                                                         1 0 0 0
во
     2 Node ID, Node coord. (meters) x,y,z
BO 2 Node ID, Node structual joint ID
     3 Body ID number
                                                                         3
BO
      3 Type (Rigid, Flexible, NASTRAN)
                                                                         R
BO
     3 Number of modes
     3 Modal calculation option (0, 1 or 2)
во
     3 Foreshortening option (Y/N)
BO
     3 Model reduction method (NO,MS,MC,CC,QM,CV)
     3 NASTRAN data file FORTRAN unit number (40 - 60)
BO
     3 Number of augmented nodes (0 if none)
      3 Damping matrix option (NS,CD,HL,SD)
     3 Constant damping ratio
3 Low frequency, High frequency ratios
BO
BO
BO
     3 Mode ID number, damping ratio
BO 3 Conversion factors: Length, Mass, Force
     3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
BO
     3 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                         9.1999324E-6 9.199954E-6 9.2E-6
во
     3 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                         0 0 0
BO
                                                                         0.06335
     3 Mass (kg)
BO
во
     3 Number of Nodes
BO
     3 Node ID, Node coord. (meters) x,y,z
3 Node ID, Node coord. (meters) x,y,z
                                                                         1000
                                                                         2 0 0 -5.08E-8
во
BO
     3 Node ID, Node structual joint ID
BO
     4 Body ID number
BO
     4 Type (Rigid, Flexible, NASTRAN)
                                                                         R
     4 Number of modes
BO
во
     4 Modal calculation option (0, 1 or 2)
     4 Foreshortening option (Y/N)
     4 Model reduction method (NO, MS, MC, CC, QM, CV)
BO
BO
     4 NASTRAN data file FORTRAN unit number (40 - 60)
    4 Number of augmented nodes (0 if none)
BO
     4 Damping matrix option (NS,CD,HL,SD)
BO 4 Constant damping ratio
BO 4 Low frequency, High frequency ratios
     4 Mode ID number, damping ratio
```

```
4 Conversion factors: Length, Mass, Force
     RO
          4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                           9.1999324E-6 9.199954E-6 9.2E-6
     во
          4 Moments of inertia (kg-m2) Ixx, Iyy, Izz
          4 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                           0 0 0
     BO
                                                                           .06335
     во
          4 Mass (kg)
     во
          4 Number of Nodes
                                                                           1 0 0 0
          4 Node ID, Node coord. (meters) x,y,z
     BO
          4 Node ID, Node coord. (meters) x,y,z
                                                                           2 0 0 -5.08E-8
     во
          4 Node ID, Node structual joint ID
     BO
     BO
          5 Body ID number
                                                                           R
          5 Type (Rigid, Flexible, NASTRAN)
     BO
          5 Number of modes
     RΩ
          5 Modal calculation option (0, 1 or 2)
     BO
          5 Foreshortening option (Y/N)
     BO
         5 Model reduction method (NO, MS, MC, CC, QM, CV)
     во
          5 NASTRAN data file FORTRAN unit number (40 - 60)
     во
          5 Number of augmented nodes (0 if none)
     BO
          5 Damping matrix option (NS,CD,HL,SD)
          5 Constant damping ratio
     BO
          5 Low frequency, High frequency ratios
     BO
          5 Mode ID number, damping ratio
     RΩ
          5 Conversion factors: Length, Mass, Force
     BO
          5 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
     во
                                                                           9.1999324E-6 9.199954E-6 9.2E-6
          5 Moments of inertia (kg-m2) Ixx, Iyy, Izz
     BO
          5 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                           0 0 0
     во
                                                                           .06335
     RO
          5 Mass (kg)
          5 Number of Nodes
     BO
                                                                           1 0 0 0
          5 Node ID, Node coord. (meters) x,y,z
     RΩ
                                                                           2 0 0 -5.08E-8
          5 Node ID, Node coord. (meters) x,y,z
          5 Node ID, Node structual joint ID
     BO
                                                                           6
          6 Body ID number
     BO
                                                                           R
          6 Type (Rigid, Flexible, NASTRAN)
     BO
     во
          6 Number of modes
     BO
          6 Modal calculation option (0, 1 or 2)
          6 Foreshortening option (Y/N)
          6 Model reduction method (NO, MS, MC, CC, QM, CV)
     BO
          6 NASTRAN data file FORTRAN unit number (40 - 60)
     во
          6 Number of augmented nodes (0 if none)
     BO
          6 Damping matrix option (NS,CD,HL,SD)
     во
     во
          6 Constant damping ratio
     BO
          6 Low frequency, High frequency ratios
          6 Mode ID number, damping ratio
          6 Conversion factors: Length, Mass, Force
     BO
          6 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                           9.1999324E-6 9.199954E-6 9.2E-6
          6 Moments of inertia (kg-m2) Ixx, Iyy, Izz
     BO
                                                                           0 0 0
     BO
          6 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                           .06335
     BO
          6 Mass (kg)
          6 Number of Nodes
                                                                           2
                                                                           1 0 0 0
          6 Node ID, Node coord. (meters) x,y,z
     BO
                                                                           2 0 0 -5.08E-8
          6 Node ID, Node coord. (meters) x,y,z
          6 Node ID, Node structual joint ID
            HINGE
         1 Hinge ID number
          1 Inboard body ID, Outboard body ID
         1 "p" node ID, "q" node ID
    нT
         1 Number of rotation DOFs, Rotation option (F or G)
         1 L1 unit vector in inboard body coord. x,y,z
                                                                           0 1 0
                                                                           0 0 1
         1 L1 unit vector in outboard body coord. x,y,z
        1 L2 unit vector in inboard body coord. x,y,z
         1 L2 unit vector in outboard body coord. x,y,z
         1 L3 unit vector in inboard body coord. x, y, z
                                                                           1 0 0
         1 L3 unit vector in outboard body coord. x,y,z
                                                                           0 1 0
    HT
         1 Initial rotation angles (deg)
                                                        78.025 0.0 98.25 78.01947099188411 0.0
98.25124323660548
    HI 1 Initial rotation rates (deg/sec)-0.2582867196 1.7813724963 0 0 0 1.8
HI 1 Rotation stiffness (newton-meters/rad) 0 0 0
```

| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Rotation damping (newton-meters/rad/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 0 0                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Null torque angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Number of translation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                              |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 First translation unit vector g1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Second translation unit vector g2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0 1 0                                                                                                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0 0 1                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Initial translation (meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -6875220.6 0 -1458238.2                                                                                                        |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Initial translation velocity (meters/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 -7533.0 0                                                                                                                    |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Translation stiffness (newtons/meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0 0 0                                                                                                                          |
| ΗI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Translation damping (newtons/meter/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 Null force translations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0 0 0                                                                                                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | •                                                                                                                              |
| ΗI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Hinge ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2                                                                                                                              |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Inboard body ID, Outboard body ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1 2                                                                                                                            |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 "p" node ID, "q" node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4 1                                                                                                                            |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Number of rotation DOFs, Rotation option (F or G)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0                                                                                                                              |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L1 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L1 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L2 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L2 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L3 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0 0 1                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 L3 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0 0 1                                                                                                                          |
| ΗI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Initial rotation angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0 0 0                                                                                                                          |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Initial rotation rates (deg/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Rotation stiffness (newton-meters/rad)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Rotation damping (newton-meters/rad/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Null torque angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |
| HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Number of translation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                              |
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| ΗI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2 Translation damping (newtons/meter/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0 0 0                                                                                                                          |
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| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3 1 3 9 2 0 1 0 0 1 0 0 0 0 1 0 0 1 0 0 0                                                                                      |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3 1 3 9 2 0 1 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0                                                                                  |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0                                                                          |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1 3 Second translation unit vector g2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1                                                                    |
| HI H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 4 Rotation stiffness (newton-meters/rad) 5 Rotation damping (newton-meters/rad/sec) 5 Null torque angles (deg) 6 Number of translation DOFs 7 First translation unit vector g1 7 Second translation unit vector g2 7 Third translation unit vector g3 7 Initial translation (meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 3 1 0 0 0 1 0 0 0 1                                                                  |
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| HI H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <pre>3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 4 Rotation damping (newton-meters/rad/sec) 5 Null torque angles (deg) 6 Number of translation DOFs 7 First translation unit vector g1 7 Second translation unit vector g2 7 Third translation unit vector g3 7 Initial translation (meters) 7 Initial translation velocity (meters/sec) 7 Translation stiffness (newtons/meters) 7 Translation damping (newtons/meters)</pre>                                                                                                                                                                                                                                                                                                          | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10 10 10 1.125 1.125 1.125                             |
| HI H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <pre>3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1 3 Second translation unit vector g2 3 Third translation unit vector g3 3 Initial translation (meters) 3 Initial translation velocity (meters/sec) 3 Translation stiffness (newtons/meters)</pre>                                                                                                                                                                                                                                                                                                                                                 | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0  0 0 1 0 0 0  3 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 10 10. 10.                                   |
| HI HILL HILL HILL HILL HILL HILL HILL H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <pre>3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1 3 Second translation unit vector g2 3 Third translation unit vector g3 3 Initial translation (meters) 3 Initial translation velocity (meters/sec) 3 Translation stiffness (newtons/meters) 3 Translation damping (newtons/meter/sec) 3 Null force translations</pre>                                                                                                                                                                                                                                                                             | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10 10 10 1.125 1.125 1.125                             |
| HI HILL HILL HILL HILL HILL HILL HILL H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <pre>3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 4 Initial rotation angles (deg) 5 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 7 Rotation damping (newton-meters/rad/sec) 8 Null torque angles (deg) 8 Number of translation DOFs 9 First translation unit vector g1 9 Second translation unit vector g2 9 Third translation unit vector g3 9 Initial translation unit vector g3 9 Initial translation velocity (meters/sec) 9 Translation stiffness (newtons/meters) 9 Translation damping (newtons/meters) 9 Translation damping (newtons/meter/sec) 9 Null force translations</pre>                                                                                                                                                                                                                                | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 10. 10. 10. 1.125 1.125 1.125 0 0 0              |
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| HI HILL HILL HILL HILL HILL HILL HILL H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1 3 Second translation unit vector g2 3 Third translation unit vector g3 3 Initial translation (meters) 3 Initial translation velocity (meters/sec) 3 Translation stiffness (newtons/meters) 3 Translation damping (newtons/meters) 4 Translation damping (newtons/meter/sec) 5 Null force translations  4 Hinge ID number 4 Inboard body ID, Outboard body ID 4 "p" node ID, "q" node ID 5 Number of rotation DOFs, Rotation option (F or G)                                                                                                           | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0  0 0 1 0 0 0  0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10. 10. 10. 1.125 1.125 0 0 0  4 1 4 10 2 0          |
| HI HILL HILL HILL HILL HILL HILL HILL H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation angles (deg) 4 Rotation stiffness (newton-meters/rad) 5 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 7 Number of translation DOFs 7 First translation unit vector g1 7 Second translation unit vector g2 7 Third translation unit vector g3 7 Initial translation (meters) 7 Initial translation velocity (meters/sec) 7 Translation stiffness (newtons/meters) 7 Translation damping (newtons/meters) 7 Translation damping (newtons/meter/sec) 7 Null force translations 7 Hinge ID number 7 Inboard body ID, Outboard body ID 7 "p" node ID, "q" node ID 7 Number of rotation DOFs, Rotation option (F or G) 7 L1 unit vector in inboard body coord. x,y,z                                                                 | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10. 10. 10. 1.125 1.125 1.125 0 0 0 4 1 4 10 2 0 1 0 0 |
| HI TITLE THE TELEVISION OF THE | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 3 Rotation damping (newton-meters/rad/sec) 3 Null torque angles (deg) 3 Number of translation DOFs 3 First translation unit vector g1 3 Second translation unit vector g2 3 Third translation unit vector g3 3 Initial translation (meters) 3 Initial translation velocity (meters/sec) 3 Translation stiffness (newtons/meters) 3 Translation damping (newtons/meters) 4 Hinge ID number 4 Inboard body ID, Outboard body ID 4 "p" node ID, "q" node ID 4 Number of rotation DOFs, Rotation option (F or G) 4 L1 unit vector in inboard body coord. x,y,z 4 L1 unit vector in outboard body coord. x,y,z                                                                                   | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0  0 0 1 0 0 0  0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10. 10. 10. 1.125 1.125 0 0 0  4 1 4 10 2 0          |
| HI TITITITITITITITITITITITITITITITITITIT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3 Hinge ID number 3 Inboard body ID, Outboard body ID 3 "p" node ID, "q" node ID 3 No of rotation DOFs, Hinge 1 rotation option(F/G) 3 L1 unit vector in inboard body coord. x,y,z 3 L1 unit vector in outboard body coord. x,y,z 3 L2 unit vector in inboard body coord. x,y,z 3 L2 unit vector in outboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in inboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 L3 unit vector in outboard body coord. x,y,z 3 Initial rotation angles (deg) 3 Initial rotation rates (deg/sec) 3 Rotation stiffness (newton-meters/rad) 4 Rotation damping (newton-meters/rad/sec) 5 Null torque angles (deg) 6 Number of translation DOFs 7 First translation unit vector g1 7 Second translation unit vector g2 7 Third translation unit vector g3 7 Initial translation (meters) 7 Initial translation (meters) 8 Initial translation velocity (meters/sec) 9 Translation stiffness (newtons/meters) 9 Translation damping (newtons/meters/sec) 9 Null force translations  4 Hinge ID number 4 Inboard body ID, Outboard body ID 5 Number of rotation DOFs, Rotation option (F or G) 8 L1 unit vector in inboard body coord. x,y,z 9 L2 unit vector in outboard body coord. x,y,z | 3 1 3 9 2 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 10. 10. 10. 1.125 1.125 1.125 0 0 0 4 1 4 10 2 0 1 0 0 |
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| HI       | 4 L3 unit vector in outboard body coord. x,y,z                                               | 0 0 1                      |
|----------|----------------------------------------------------------------------------------------------|----------------------------|
| HI       | 4 Initial rotation angles (deg)                                                              | 0 0 0                      |
| HI       | 4 Initial rotation rates (deg/sec)                                                           |                            |
| HI       | 4 Rotation stiffness (newton-meters/rad)                                                     |                            |
| HI       | 4 Rotation damping (newton-meters/rad/sec)                                                   |                            |
| HI       | 4 Null torque angles (deg)                                                                   | •                          |
| HI       | 4 Number of translation DOFs                                                                 | 3                          |
| HI       | 4 First translation unit vector g1                                                           | 1 0 0                      |
| HI       | 4 Second translation unit vector g2                                                          | 0 1 0                      |
| HI       | 4 Third translation unit vector g3                                                           | 0 0 1                      |
| HI       | 4 Initial translation (meters)                                                               | 0 0 0                      |
| ΗĬ       | 4 Initial translation velocity (meters/sec)                                                  | 0 0 0                      |
| HI       | 4 Translation stiffness (newtons/meters)                                                     | 10 10 10                   |
| HI       | 4 Translation damping (newtons/meter/sec)                                                    | 1.125 1.125 1.125          |
| HI       | 4 Null force translations                                                                    | 0 0 0                      |
|          |                                                                                              | <b>5</b>                   |
| HI       | 5 Hinge ID number                                                                            | 5                          |
| HI       | 5 Inboard body ID, Outboard body ID                                                          | 1 5                        |
| HI       | 5 "p" node ID, "q" node ID                                                                   | 11 2                       |
| HI       | 5 Number of rotation DOFs                                                                    | 0                          |
| HI       | 5 L1 unit vector in inboard body coord. x,y,z                                                | 1 0 0                      |
| HI       | 5 L1 unit vector in outboard body coord. x,y,z                                               | 1 0 0                      |
| HI       | 5 L2 unit vector in inboard body coord. x,y,z                                                |                            |
| HI       | 5 L2 unit vector in outboard body coord. x,y,z                                               | 0 0 1                      |
| HI       | 5 L3 unit vector in inboard body coord. x,y,z                                                | 0 0 1                      |
| ΗI       | 5 L3 unit vector in outboard body coord. x,y,z                                               | 0 0 1                      |
| HI       | 5 Initial rotation angles (deg)                                                              | 0 0 0                      |
| HI       | 5 Initial rotation rates (deg/sec)                                                           |                            |
| HI       | 5 Rotation stiffness (newton-meters/rad)                                                     |                            |
| HI       | 5 Rotation damping (newton-meters/rad/sec)                                                   |                            |
| HI       | 5 Null torque angles (deg)                                                                   | 2                          |
| HI       | 5 Number of translation DOFs                                                                 | 3                          |
| HI       | 5 First translation unit vector g1                                                           | 1 0 0                      |
| HI       | 5 Second translation unit vector g2                                                          | 0 1 0                      |
| HI       | 5 Third translation unit vector g3                                                           | 0 0 1                      |
| HI       | 5 Initial translation (meters)                                                               | 0 0 0                      |
| ΗI       | 5 Initial translation velocity (meters/sec)                                                  | 0 0 0                      |
| HI       | 5 Translation stiffness (newtons/meters)                                                     | 10 10 10                   |
| ΗI       | 5 Translation damping (newtons/meter/sec)                                                    | 1.125 1.125 1.125<br>0 0 0 |
| HI       | 5 Null force translations                                                                    | 0 0 0                      |
|          | C Winner TD number                                                                           | 6                          |
| HI       | 6 Hinge ID number                                                                            | 1 6                        |
| HI       | 6 Inboard body ID, Outboard body ID                                                          | 12 2                       |
| HI       | 6 "p" node ID, "q" node ID                                                                   | 0                          |
| HI       | 6 Number of rotation DOFs                                                                    | 1 0 0                      |
| HI       | 6 L1 unit vector in inboard body coord. x,y,z                                                | 1 0 0                      |
| HI<br>HI | 6 L1 unit vector in outboard body coord. x,y,z 6 L2 unit vector in inboard body coord. x,y,z | 100                        |
| HI       |                                                                                              |                            |
| HI       | 6 L3 unit vector in inboard body coord. x,y,z                                                | 0 0 1                      |
| HI       | 6 L3 unit vector in outboard body coord. x,y,z                                               | 0 0 1                      |
| HI       | 6 Initial rotation angles (deg)                                                              | 0 0 0                      |
| HI       | 6 Initial rotation rates (deg/sec)                                                           |                            |
| HI       | 6 Rotation stiffness (newton-meters/rad)                                                     |                            |
| HI       | 6 Rotation damping (newton-meters/rad/sec)                                                   |                            |
| ΗI       | 6 Null torque angles (deg)                                                                   |                            |
| HI       | 6 Number of translation DOFs                                                                 | 3                          |
| HI       | 6 First translation unit vector g1                                                           | 1 0 0                      |
| HI       | 6 Second translation unit vector g2                                                          | 0 1 0                      |
| HI       | 6 Third translation unit vector g3                                                           | 0 0 1                      |
| HI       | 6 Initial translation (meters)                                                               | 0 0 0                      |
| HI       | 6 Initial translation velocity (meters/sec)                                                  | 0 0 0                      |
| HI       | 6 Translation stiffness (newtons/meters)                                                     | 10 10 10                   |
| HI       |                                                                                              |                            |
|          | 6 Translation damping (newtons/meter/sec)                                                    | 1.125 1.125 1.125          |
| HI       | 6 Translation damping (newtons/meter/sec) 6 Null force translations                          | 1.125 1.125 1.125<br>0 0 0 |
| HI       | <del>-</del> -                                                                               |                            |

#### SENSOR

```
SE 1 Sensor ID number 1
SE 1 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) G
```

```
1 3
          1 Mounting point body ID, Mounting point node ID
          1 Second mounting point body ID, Second node ID
                                                                            0 0 1
     SE
          1 Input axis unit vector (IA) x,y,z
         1 Mounting point Hinge index, Axis index
         1 First focal plane unit vector (Fp1) x,y,z
         1 Second focal plane unit vector (Fp2) x,y,z
          1 Sun/Star unit vector (Us) x,y,z
     SE
         1 Velocity Aberration Option (Y/N)
         1 Euler Angle Sequence (1-6)
          1 CMG ID number and Gimbal number
         1 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
     SE
          2 Sensor ID number
          2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                            1 3
         2 Mounting point body ID, Mounting point node ID
          2 Second mounting point body ID, Second node ID
                                                                            0 1 0
          2 Input axis unit vector (IA) x,y,z
          2 Mounting point Hinge index, Axis index
          2 First focal plane unit vector (Fp1) x,y,z
          2 Second focal plane unit vector (Fp2) x,y,z
          2 Sun/Star unit vector (Us) x,y,z
         2 Velocity Aberration Option (Y/N)
         2 Euler Angle Sequence (1-6)
          2 CMG ID number and Gimbal number
     SE
          2 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
          3 Sensor ID number
     SE
          3 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                            1 3
          3 Mounting point body ID, Mounting point node ID
          3 Second mounting point body ID, Second node ID
          3 Input axis unit vector (IA) x,y,z
                                                                            1 0 0
     SE
          3 Mounting point Hinge index, Axis index
          3 First focal plane unit vector (Fp1) x,y,z
     SE
          3 Second focal plane unit vector (Fp2) x,y,z
          3 Sun/Star unit vector (Us) x,y,z
          3 Velocity Aberration Option (Y/N)
     SE
          3 Euler Angle Sequence (1-6)
          3 CMG ID number and Gimbal number
     SE
          3 Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s])
     SE
          4 Sensor ID number
          4 Type (G, R, AN, V, P, AC, T, I, SU, ST, L, IM, P3, V3, CR, CT, ET, LV, A3, FM)
                                                                            ST
     SE
     SE
          4 Mounting point body ID, Mounting point node ID
          4 Second mounting point body ID, Second node ID
         4 Input axis unit vector (IA) x,y,z
     SE
          4 Mounting point Hinge index, Axis index
        4 First focal plane unit vector (Fp1) x,y,z
4 Second focal plane unit vector (Fp2) x,y,z
4 Sun/Star unit vector (Us) x,y,z
                                                                            1 0 0
     SE
     SE
                                                                            .968114817 -0.143492622
     SE
0.205337693
    SE 4 Velocity Aberration Option (Y/N)
          4 Euler Angle Sequence (1-6)
    SE 4 CMG ID number and Gimbal number
     SE 4 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
    SE
         5 Sensor ID number
    SE 5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                            P3
    SE 5 Mounting point body ID, Mounting point node ID
                                                                            1 4
                                                                            2 1
          5 Second mounting point body ID, Second node ID
        5 Input axis unit vector (IA) x,y,z
    SE
         5 Mounting point Hinge index, Axis index
         5 First focal plane unit vector (Fp1) x,y,z
5 Second focal plane unit vector (Fp2) x,y,z
    SE
    SE
          5 Sun/Star unit vector (Us) x,y,z
         5 Velocity Aberration Option (Y/N)
    SE
    SE
          5 Euler Angle Sequence (1-6)
    SE 5 CMG ID number and Gimbal number
    SE 5 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
    SE
          6 Sensor ID number
    SE 6 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
```

```
2 1
     6 Mounting point body ID, Mounting point node ID
     6 Second mounting point body ID, Second node ID
                                                                     1 0 0
SE
     6 Input axis unit vector (IA) x,y,z
     6 Mounting point Hinge index, Axis index
     6 First focal plane unit vector (Fp1) x,y,z
SE
     6 Second focal plane unit vector (Fp2) x,y,z
     6 Sun/Star unit vector (Us) x,y,z
     6 Velocity Aberration Option (Y/N)
SE
     6 Euler Angle Sequence (1-6)
SE
     6 CMG ID number and Gimbal number
    6 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
SE
     7 Sensor ID number
     7 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                     AC
SE
                                                                      2 1
     7 Mounting point body ID, Mounting point node ID
SE
     7 Second mounting point body ID, Second node ID
     7 Input axis unit vector (IA) x,y,z
                                                                     0 1 0
SE
     7 Mounting point Hinge index, Axis index
SE
     7 First focal plane unit vector (Fp1) x,y,z
     7 Second focal plane unit vector (Fp2) x,y,z
SE
     7 Sun/Star unit vector (Us) x,y,z
     7 Velocity Aberration Option (Y/N)
SE
     7 Euler Angle Sequence (1-6)
SE
     7 CMG ID number and Gimbal number
SE
     7 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
SE
     8 Sensor ID number
     8 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                     AC
     8 Mounting point body ID, Mounting point node ID
                                                                     2 1
     8 Second mounting point body ID, Second node ID
                                                                     0 0 1
SE
     8 Input axis unit vector (IA) x,y,z
SE
     8 Mounting point Hinge index, Axis index
     8 First focal plane unit vector (Fp1) x,y,z
     8 Second focal plane unit vector (Fp2) x,y,z
     8 Sun/Star unit vector (Us) x,y,z
SE
     8 Velocity Aberration Option (Y/N)
     8 Euler Angle Sequence (1-6)
SE
     8 CMG ID number and Gimbal number
SE
     8 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
     9 Sensor ID number
     9 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE
                                                                     1 3
     9 Mounting point body ID, Mounting point node ID
     9 Second mounting point body ID, Second node ID
                                                                     0 0 1
     9 Input axis unit vector (IA) x,y,z
     9 Mounting point Hinge index, Axis index
     9 First focal plane unit vector (Fp1) x,y,z
SE
     9 Second focal plane unit vector (Fp2) x,y,z
     9 Sun/Star unit vector (Us) x,y,z
     9 Velocity Aberration Option (Y/N)
     9 Euler Angle Sequence (1-6)
SE
     9 CMG ID number and Gimbal number
     9 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
                                                                     10
SE 10 Sensor ID number
   10 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                     P3
SE 10 Mounting point body ID, Mounting point node ID
                                                                     3 1
SE 10 Second mounting point body ID, Second node ID
   10 Input axis unit vector (IA) x,y,z
SE 10 Mounting point Hinge index, Axis index
SE 10 First focal plane unit vector (Fp1) x,y,z
SE 10 Second focal plane unit vector (Fp2) x,y,z
   10 Sun/Star unit vector (Us) x,y,z
SE 10 Velocity Aberration Option (Y/N)
SE 10 Euler Angle Sequence (1-6)
SE 10 CMG ID number and Gimbal number
SE 10 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                     11
SE 11 Sensor ID number
SE 11 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE 11 Mounting point body ID, Mounting point node ID
                                                                     1 9
```

SE 16 Sensor ID number

Contract No.: NAS8-00114 3 1 SE 11 Second mounting point body ID, Second node ID SE 11 Input axis unit vector (IA) x,y,z SE 11 Mounting point Hinge index, Axis index SE 11 First focal plane unit vector (Fp1) x,y,z SE 11 Second focal plane unit vector (Fp2) x,y,zSE 11 Sun/Star unit vector (Us) x,y,z SE 11 Velocity Aberration Option (Y/N) SE 11 Euler Angle Sequence (1-6) SE 11 CMG ID number and Gimbal number SE 11 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 12 SE 12 Sensor ID number SE 12 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) FΜ 1 1 SE 12 Mounting point body ID, Mounting point node ID SE 12 Second mounting point body ID, Second node ID SE 12 Input axis unit vector (IA) x,y,z 12 Mounting point Hinge index, Axis index 12 First focal plane unit vector (Fp1) x,y,z SE 12 Second focal plane unit vector (Fp2) x,y,z SE 12 Sun/Star unit vector (Us) x,y,z 12 Velocity Aberration Option (Y/N) SE 12 Euler Angle Sequence (1-6) SE 12 CMG ID number and Gimbal number SE 12 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 13 SE 13 Sensor ID number SE 13 Typ (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) FM SE 13 Mounting point body ID, Mounting point node ID 1 2 SE 13 Second mounting point body ID, Second node ID SE 13 Input axis unit vector (IA) x,y,z SE 13 Mounting point Hinge index, Axis index 13 First focal plane unit vector (Fp1) x,y,z SE 13 Second focal plane unit vector (Fp2) x,y,z SE 13 Sun/Star unit vector (Us) x,y,z SE 13 Velocity Aberration Option (Y/N) SE 13 Euler Angle Sequence (1-6) SE 13 CMG ID number and Gimbal number SE 13 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 14 SE 14 Sensor ID number SE 14 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) FM SE 14 Mounting point body ID, Mounting point node ID 1 13 14 Second mounting point body ID, Second node ID SE 14 Input axis unit vector (IA) x,y,z SE 14 Mounting point Hinge index, Axis index SE 14 First focal plane unit vector (Fp1) x,y,z 14 Second focal plane unit vector (Fp2) x,y,z SE 14 Sun/Star unit vector (Us) x,y,z 14 Velocity Aberration Option (Y/N) SE 14 Euler Angle Sequence (1-6) SE 14 CMG ID number and Gimbal number SE 14 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) SE 15 Sensor ID number 15 SE 15 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) 15 Mounting point body ID, Mounting point node ID 1 1 SE 15 Second mounting point body ID, Second node ID 1 0 0 SE 15 Input axis unit vector (IA) x,y,z SE 15 Mounting point Hinge index, Axis index 15 First focal plane unit vector (Fp1) x,y,z SE 15 Second focal plane unit vector (Fp2) x,y,z SE 15 Sun/Star unit vector (Us) x,y,z 15 Velocity Aberration Option (Y/N) SE 15 Euler Angle Sequence (1-6) SE 15 CMG ID number and Gimbal number SE 15 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])

SE 16 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)

SE 16 Mounting point body ID, Mounting point node ID SE 16 Second mounting point body ID, Second node ID

Date: 14 February 2003

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MG

Contract No.: NAS8-00114 SE 16 Input axis unit vector (IA) x,y,z 1 0 0 16 Mounting point Hinge index, Axis index SE 16 First focal plane unit vector (Fp1) x,y,z SE 16 Second focal plane unit vector (Fp2) x,y,z SE 16 Sun/Star unit vector (Us) x,y,z 16 Velocity Aberration Option (Y/N) SE 16 Euler Angle Sequence (1-6) SE 16 CMG ID number and Gimbal number SE 16 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) SE 17 Sensor ID number 17 SE 17 Typ (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) LV SE 17 Mounting point body ID, Mounting point node ID 1,1 SE 17 Second mounting point body ID, Second node ID SE 17 Input axis unit vector (IA) x,y,z SE 17 Mounting point Hinge index, Axis index 17 First focal plane unit vector (Fp1) x,y,z SE 17 Second focal plane unit vector (Fp2) x,y,z SE 17 Sun/Star unit vector (Us) x,y,z SE 17 Velocity Aberration Option (Y/N) SE 17 Euler Angle Sequence (1-6) SE 17 CMG ID number and Gimbal number SE 17 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) SE 18 Sensor ID number 18 SE 18 Typ (G, R, AN, V, P, AC, T, I, SU, ST, L, IM, P3, V3, CR, CT, ET, LV, A3, FM) FΜ 2 1 SE 18 Mounting point body ID, Mounting point node ID SE 18 Second mounting point body ID, Second node ID SE 18 Input axis unit vector (IA) x,y,z SE 18 Mounting point Hinge index, Axis index SE 18 First focal plane unit vector (Fp1) x,y,z 18 Second focal plane unit vector (Fp2) x,y,z SE 18 Sun/Star unit vector (Us) x,y,z SE 18 Velocity Aberration Option (Y/N) 18 Euler Angle Sequence (1-6) SE 18 CMG ID number and Gimbal number SE 18 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) ACTR 1 Actuator ID number AC 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) AC 1 Actuator location; Node or Hinge (N or H) 1 5 AC 1 Mounting point body ID number, node ID number 1 Second mounting point body ID, second node ID AC 1 Output axis unit vector x,y,z 1 0 0 AC 1 Mounting point Hinge index, Axis index 1 Rotor spin axis unit vector x,y,z AC 1 Initial rotor momentum, H 1 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 1 Outer gimbal axis unit vector x,y,z
1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC AC AC 1 Inner gimbal- angle(deg), inertia, friction(D, S, B, N) AC 1 Inner gimbal axis unit vector x,y,z 1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC 1 Initial length and rate, y(to) and ydot(to) AC 1 Constants; K1 or wo, n or zeta, Kg, Jm 1 Non-linearities; TLim, Tco, Dz 2 Actuator ID number 2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) ΑÇ 2 Actuator location; Node or Hinge (N or H) 2 Mounting point body ID number, node ID number 1 6 2 Second mounting point body ID, second node ID -1 0 0 AC 2 Output axis unit vector x,y,z AC 2 Mounting point Hinge index, Axis index 2 Rotor spin axis unit vector x,y,z AC AC 2 Initial rotor momentum, H AC 2 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)

Date: 14 February 2003

2 Outer gimbal axis unit vector x,y,z

bd Systems® TCD20030028A Date: 14 February 2003 Contract No.: NAS8-00114

| AC       | 2 Out gim fric (Tfi, Tgfo, GAM)                                           | (Tfi,M,D,Kf)/(m,M,B,k)                |      |
|----------|---------------------------------------------------------------------------|---------------------------------------|------|
| AC       | 2 Inner gimbal- angle(deg), ine                                           |                                       |      |
| AC       | 2 Inner gimbal axis unit vector                                           |                                       |      |
| AC<br>AC | <pre>2 In gim fric (Tfi,Tgfo,GAM)/( 2 Initial length and rate, y(t)</pre> |                                       |      |
| AC       | 2 Constants; K1 or wo, n or ze                                            |                                       |      |
| AC       | 2 Non-linearities; TLim, Tco,                                             |                                       |      |
|          |                                                                           |                                       |      |
| AC       | 3 Actuator ID number                                                      | 3                                     |      |
| AC       | 3 Type(J,H,MO,T,B,MA,SG,DG,W,I                                            |                                       |      |
| AC<br>AC | 3 Actuator location; Node or F<br>3 Mounting point body ID number         |                                       | 7    |
| AC       | 3 Second mounting point body 1                                            |                                       | •    |
| AC       | 3 Output axis unit vector x,y,                                            | 1 (                                   | 0 0  |
| AC       | 3 Mounting point Hinge index,                                             |                                       |      |
| AC       | 3 Rotor spin axis unit vector                                             | x,y,z                                 |      |
| AC<br>AC | <pre>3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),ine</pre>     | ertia frigtion/D C R N)               |      |
| AC       | 3 Outer gimbal axis unit vector                                           |                                       |      |
| AC       | 3 Out gim fric (Tfi, Tgfo, GAM)                                           |                                       |      |
| AC       | 3 Inner gimbal- angle(deg), inc                                           |                                       |      |
| AC       | 3 Inner gimbal axis unit vector                                           |                                       |      |
| AC       | 3 In gim fric (Tfi, Tgfo, GAM)/                                           |                                       |      |
| AC<br>AC | 3 Initial length and rate, y(t<br>3 Constants; K1 or wo, n or ze          | <del>-</del>                          |      |
| AC       | 3 Non-linearities; TLim, Tco,                                             | · · · · · · · · · · · · · · · · · · · |      |
|          | 3 Hom Timediffered, 121m, 100,                                            |                                       |      |
| AC       | 4 Actuator ID number                                                      | 4                                     |      |
| AC       | 4 Type(J,H,MO,T,B,MA,SG,DG,W,I                                            |                                       |      |
| AC       | 4 Actuator location; Node or F                                            |                                       | 2    |
| AC<br>AC | 4 Mounting point body ID number<br>4 Second mounting point body I         | D. second rode ID                     | ,    |
| AC       | 4 Output axis unit vector x, y,                                           |                                       | 0 0  |
| AC       | 4 Mounting point Hinge index,                                             |                                       |      |
| AC       | 4 Rotor spin axis unit vector                                             | x,y,z                                 |      |
| AC       | 4 Initial rotor momentum, H                                               | ontic foignism (D. C. D. M)           |      |
| AC<br>AC | 4 Outer gimbal - angle(deg), ine<br>4 Outer gimbal axis unit vector       |                                       |      |
| AC       | 4 Out gim fric (Tfi, Tgfo, GAM)/                                          | · <del>-</del> ·                      |      |
| AC       | 4 Inner gimbal- angle (deg), ine                                          |                                       |      |
| AC       | 4 Inner gimbal axis unit vecto                                            |                                       |      |
| AC       | 4 In gim fric (Tfi, Tgfo, GAM)/(                                          |                                       |      |
| AC       | 4 Initial length and rate, y(t                                            |                                       |      |
| AC<br>AC | 4 Constants; K1 or wo, n or ze<br>4 Non-linearities; TLim, Tco,           |                                       |      |
|          |                                                                           |                                       |      |
| AC       | 5 Actuator ID number                                                      |                                       |      |
| AC<br>AC | 5 Type(J,H,MO,T,B,MA,SG,DG,W,L<br>5 Actuator location; Node or H          |                                       |      |
| AC       | 5 Mounting point body ID number                                           | r, node ID number 1 8                 | 3    |
| AC       | 5 Second mounting point body I                                            | D, second node ID                     |      |
| AC       | 5 Output axis unit vector x,y,                                            |                                       | 1. 0 |
| AC       | 5 Mounting point Hinge index,                                             |                                       |      |
| AC<br>AC | 5 Rotor spin axis unit vector<br>5 Initial rotor momentum, H              | X, Y, 2                               |      |
| AC       | 5 Outer gimbal- angle(deg), ine                                           | rtia, friction(D, S, B, N)            |      |
| AC       | 5 Outer gimbal axis unit vecto                                            |                                       |      |
| AC       | 5 Out gim fric (Tfi, Tgfo, GAM)/                                          |                                       |      |
| AC       | 5 Inner gimbal- angle(deg), ine<br>5 Inner gimbal axis unit vecto         |                                       |      |
| AC<br>AC | 5 In gim fric (Tfi, Tgfo, GAM)/(                                          | · =                                   |      |
| AC       | 5 Initial length and rate, y(t                                            |                                       |      |
| AC       | 5 Constants; K1 or wo, n or ze                                            |                                       |      |
| AC       | 5 Non-linearities; TLim, Tco,                                             | Dz                                    |      |
| AC       | 6 Actuator ID number                                                      | 6                                     |      |
| AC       | 6 Type (J,H,MO,T,B,MA,SG,DG,W,L                                           |                                       |      |
| AC       | 6 Actuator location; Node or H                                            | inge (N or H)                         |      |
| AC       | 6 Mounting point body ID number                                           |                                       | 3    |
| AC       | 6 Second mounting point body I                                            |                                       | -1 0 |
| AC       | 6 Output axis unit vector x,y,                                            | z 0 -                                 | Τ.0  |

| AC                                                       | ε                                                   | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
|----------------------------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| AC                                                       |                                                     | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |
| AC                                                       |                                                     | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |
| AC                                                       |                                                     | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |
| AC                                                       |                                                     | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |
| AC                                                       |                                                     | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |
| AC                                                       |                                                     | Inner gimbal - angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         |
| AC<br>AC                                                 |                                                     | <pre>Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         |
| AC                                                       |                                                     | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | •       |
| AC                                                       |                                                     | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| AC                                                       |                                                     | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         |
|                                                          |                                                     | ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |
| AC                                                       | 7                                                   | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 7       |
| AC                                                       |                                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J       |
| AC                                                       |                                                     | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |
| AC                                                       |                                                     | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1 5     |
| AC                                                       |                                                     | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| AC                                                       |                                                     | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 1 0   |
| AC<br>AC                                                 |                                                     | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| AC                                                       |                                                     | Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |
| AC                                                       |                                                     | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |
| AC                                                       |                                                     | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |
| AC                                                       |                                                     | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |
| AC                                                       |                                                     | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |
| AC                                                       | 7                                                   | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |
| AC                                                       | 7                                                   | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| AC                                                       | 7                                                   | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |
| AC                                                       |                                                     | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| AC                                                       | 7                                                   | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         |
| 3.0                                                      | 0                                                   | Actuation ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 8       |
| AC<br>AC                                                 |                                                     | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Ĵ       |
| AC                                                       |                                                     | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | J       |
| AC                                                       |                                                     | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1 5     |
| AC                                                       |                                                     | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| AC                                                       |                                                     | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 -1 0  |
| AC                                                       | 8                                                   | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| AC                                                       |                                                     | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |
| AC                                                       | 8                                                   | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |
| AC                                                       | _                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |
|                                                          |                                                     | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |
| AC                                                       | 8                                                   | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |
| AC                                                       | 8                                                   | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| AC<br>AC                                                 | 8<br>8<br>8                                         | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |
| AC<br>AC<br>AC                                           | 8<br>8<br>8                                         | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| AC<br>AC                                                 | 8<br>8<br>8<br>8                                    | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |
| AC<br>AC<br>AC<br>AC                                     | 8<br>8<br>8<br>8<br>8                               | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |
| AC<br>AC<br>AC<br>AC<br>AC                               | 8<br>8<br>8<br>8<br>8                               | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                         | 8<br>8<br>8<br>8<br>8<br>8                          | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 8<br>8<br>8<br>8<br>8<br>8<br>8                     | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 9       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 8<br>8<br>8<br>8<br>8<br>8<br>8                     | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 9<br>J  |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 8<br>8<br>8<br>8<br>8<br>8<br>8<br>8<br>9<br>9      | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 88<br>88<br>88<br>88<br>99<br>99                    | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |         |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | 8<br>8<br>8<br>8<br>8<br>8<br>8<br>9<br>9<br>9<br>9 | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                     | J       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 8 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9             | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>17 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9             | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                       | J<br>17 |
| AC A                 | 8888889999999999                                    | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                    | J<br>17 |
| AC A                 | 888888899999999999                                  | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                 | J<br>17 |
| AC A                 | 888888899999999999                                  | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                             | J<br>17 |
| AC A                 | 8888888999999999999                                 | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                          | J<br>17 |
| AC A                 | 8888888 9999999999999                               | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                       | J<br>17 |
| AC A                 | 888888 99999999999999                               | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                   | J<br>17 |
| AC A                 | 8888888 999999999999999                             | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) | J<br>17 |
| AC A                 | 8888888 9999999999999999                            | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)         | J<br>17 |
| AC A                 | 8888888 99999999999999999                           | Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) | J<br>17 |

10

29

AC 10 Actuator ID number

| AC                                                                   | 10                                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J                  |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| AC                                                                   |                                                                                 | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |
| AC                                                                   |                                                                                 | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1 7                |
| AC<br>AC                                                             |                                                                                 | Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 -1 0             |
| AC                                                                   |                                                                                 | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0 1 0              |
| AC                                                                   |                                                                                 | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
| AC                                                                   | 10                                                                              | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                    |
| AC                                                                   |                                                                                 | Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |
| AC                                                                   |                                                                                 | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |
| AC                                                                   |                                                                                 | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |
| AC<br>AC                                                             |                                                                                 | <pre>Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
| AC                                                                   |                                                                                 | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
| AC                                                                   |                                                                                 | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |
| AC                                                                   |                                                                                 | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |
| AC                                                                   | 10                                                                              | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |
|                                                                      |                                                                                 | * · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 11                 |
| AC<br>AC                                                             |                                                                                 | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J                  |
| AC                                                                   |                                                                                 | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Ü                  |
| AC                                                                   |                                                                                 | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1 6                |
| AC                                                                   | 11                                                                              | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |
| AC                                                                   | 11                                                                              | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0 1 0              |
| AC                                                                   |                                                                                 | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |
| AC                                                                   |                                                                                 | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
| AC<br>AC                                                             |                                                                                 | <pre>Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                    |
| AC                                                                   |                                                                                 | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |
| AC                                                                   |                                                                                 | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |
| AC                                                                   |                                                                                 | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |
| AC                                                                   | 11                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |
| AC                                                                   |                                                                                 | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |
| AC                                                                   |                                                                                 | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |
| AC<br>AC                                                             |                                                                                 | Constants; K1 or wo, n or zeta, Kg, Jm<br>Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                    |
|                                                                      |                                                                                 | Non-linealities; lbim, ico, bz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |
| 110                                                                  |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                    |
| AC                                                                   |                                                                                 | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 12                 |
|                                                                      | 12                                                                              | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 12<br>J            |
| AC<br>AC<br>AC                                                       | 12<br>12<br>12                                                                  | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | J                  |
| AC<br>AC<br>AC<br>AC                                                 | 12<br>12<br>12<br>12                                                            | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 12<br>12<br>12<br>12<br>12                                                      | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 12<br>12<br>12<br>12<br>12<br>12                                                | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J                  |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 12<br>12<br>12<br>12<br>12<br>12<br>12                                          | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                     | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12                                    | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                         | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12                        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12                  | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12            | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 6           |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 6           |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 6           |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg).inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg).inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J<br>1 6           |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg).inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg).inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                      | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                        | J 1 6 0 -1 0       |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                              | J<br>1 6<br>0 -1 0 |
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| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                  | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z | J<br>1 6<br>0 -1 0 |
| AC A                             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>1 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                  | J<br>1 6<br>0 -1 0 |

| AC       | 2 13 Initial length and rate, y(to) and ydot(to)       |                |
|----------|--------------------------------------------------------|----------------|
| AC       | • • • • • • • • • • • • • • • • • • • •                |                |
| AC       | C 13 Non-linearities; TLim, Tco, Dz                    |                |
| 3.0      | 1 14 3 stuctor TD muchon                               | 14             |
| AC<br>AC |                                                        | 14<br>Ј        |
| AC       |                                                        | U              |
| AC       | · · · · · · · · · · · · · · · · · · ·                  | 1 5            |
| AC       |                                                        |                |
| AC       |                                                        | 0 0 -1         |
| AC       | <u> </u>                                               |                |
| AC       | 14 Rotor spin axis unit vector x,y,z                   |                |
| AC       | ·                                                      |                |
| AC       | 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N | )              |
| AC       | <u>-</u>                                               |                |
| AC       |                                                        |                |
| AC       |                                                        | )              |
| AC       |                                                        |                |
| AC       |                                                        |                |
| AC<br>AC |                                                        |                |
| AC       |                                                        |                |
| AC       | 14 NON-linearities; Thim, 100, bz                      |                |
| AC       | 15 Actuator ID number                                  | 15             |
| AC       |                                                        | J              |
| AC       |                                                        |                |
| AC       |                                                        | 1 8            |
| AC       | 15 Second mounting point body ID, second node ID       |                |
| AC       | - · · · · · · · · · · · · · · · · · · ·                | 0 0 1          |
| AC       |                                                        |                |
| AC       | - · · · · · · · · · · · · · · · · · · ·                |                |
| AC       | ·                                                      | ,              |
| AC       |                                                        | )              |
| AC<br>AC |                                                        | 1              |
| AC       | _ · · · · · · · · · · · · · · · · · · ·                |                |
| AC       |                                                        | ,              |
| AC       |                                                        |                |
| AC       |                                                        |                |
| AC       | 15 Constants; K1 or wo, n or zeta, Kg, Jm              |                |
| AC       | 15 Non-linearities; TLim, Tco, Dz                      |                |
|          |                                                        |                |
| AC       |                                                        | 16             |
| AC       |                                                        | J              |
| AC       |                                                        | 1 6            |
| AC<br>AC |                                                        | 1 0            |
| AC       |                                                        | 0 0 -1         |
| AC       |                                                        | <b>,</b> , , , |
| AC       | 16 Rotor spin axis unit vector x,y,z                   |                |
| AC       | 16 Initial rotor momentum, H                           |                |
| AC       |                                                        | )              |
| AC       | •                                                      |                |
| AC       |                                                        |                |
| AC       |                                                        | )              |
| AC       |                                                        |                |
| AC<br>AC |                                                        |                |
| AC       |                                                        |                |
| AC       | 16 Non-linearities; TLim, Tco, Dz                      |                |
|          | ·, ·, ·, ·                                             |                |
| AC       | 17 Actuator ID number                                  | 17             |
| AC       |                                                        | J              |
| AC       | 17 Actuator location; Node or Hinge (N or H)           |                |
| AC       | 17 Mounting point body ID number, node ID number       | 1 2            |
| AC       | 17 Second mounting point body ID, second node ID       |                |
| AC       | 17 Output axis unit vector x,y,z                       | 1 0 0          |
| 7.0      | 17 Mounting point Hinge index, Axis index              |                |
| AC       | <del>-</del>                                           |                |
| AC       | 17 Rotor spin axis unit vector x,y,z                   |                |
|          | <del>-</del>                                           | )              |

| A   | ٦ 1 - | Outer gimbal axis unit vector x,y,z                            |       |
|-----|-------|----------------------------------------------------------------|-------|
|     |       |                                                                |       |
| A   |       | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)             |       |
| A   |       | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)        |       |
| A   |       | Inner gimbal axis unit vector x,y,z                            |       |
| A   | 2 17  | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)              |       |
| A   | 17    | 'Initial length and rate, y(to) and ydot(to)                   |       |
| A   | 17    | Constants; K1 or wo, n or zeta, Kg, Jm                         |       |
| A   |       | Non-linearities; TLim, Tco, Dz                                 |       |
|     |       | Tion Illication, Illin, 100, Da                                |       |
| 3.4 | 7 10  | Actuator ID number                                             | 18    |
| A(  |       | Actuator ID number                                             |       |
| A   |       | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                            | J     |
| A   |       | Actuator location; Node or Hinge (N or H)                      |       |
| A(  |       | Mounting point body ID number, node ID number                  | 1 2   |
| A   | : 18  | Second mounting point body ID, second node ID                  |       |
| A   | 18    | Output axis unit vector x,y,z                                  | 010   |
| A   | : 18  | Mounting point Hinge index, Axis index                         |       |
| A   |       | Rotor spin axis unit vector x,y,z                              |       |
| A   |       | Initial rotor momentum, H                                      |       |
| A   |       | Outer gimbal- angle(deg),inertia,friction(D,S,B,N)             |       |
| A   |       | Outer gimbal axis unit vector x,y,z                            |       |
|     |       |                                                                |       |
| A   |       | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)             |       |
| A   |       | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)        |       |
| A   |       | Inner gimbal axis unit vector x,y,z                            |       |
| A   |       | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)              |       |
| A   |       | Initial length and rate, y(to) and ydot(to)                    |       |
| ΑC  | 18    | Constants; K1 or wo, n or zeta, Kg, Jm                         |       |
| A   |       | Non-linearities; TLim, Tco, Dz                                 |       |
|     |       | ,,,                                                            |       |
| A   | 19    | Actuator ID number                                             | 19    |
| AC  |       | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                            | J     |
| A   |       | Actuator location; Node or Hinge (N or H)                      | Ū     |
|     |       |                                                                | 1 2   |
| AC  |       | Mounting point body ID number, node ID number                  | 1 2   |
| AC  |       | Second mounting point body ID, second node ID                  | 0 0 1 |
| AC  |       | Output axis unit vector x,y,z                                  | 0 0 1 |
| AC  |       | Mounting point Hinge index, Axis index                         |       |
| AC  | : 19  | Rotor spin axis unit vector x,y,z                              |       |
| AC  | : 19  | Initial rotor momentum, H                                      |       |
| AC  | : 19  | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)        |       |
| AC  | 19    | Outer gimbal axis unit vector x,y,z                            |       |
| AC  |       | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) |       |
| AC  |       | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)        |       |
| AC  |       | Inner gimbal axis unit vector x,y,z                            |       |
| AC  |       | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)              |       |
|     |       |                                                                |       |
| AC  |       | Initial length and rate, y(to) and ydot(to)                    |       |
| AC  |       | Constants; K1 or wo, n or zeta, Kg, Jm                         |       |
| AC  | 19    | Non-linearities; TLim, Tco, Dz                                 |       |
|     |       |                                                                |       |
| AC  |       | Actuator ID number                                             | 20    |
| AC  |       | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                            | MO    |
| AC  | 20    | Actuator location; Node or Hinge (N or H)                      |       |
| AC  |       | Mounting point body ID number, node ID number                  | 1 2   |
| AC  | 20    | Second mounting point body ID, second node ID                  |       |
| AC  |       | Output axis unit vector x,y,z                                  | 1 0 0 |
| AC  |       | Mounting point Hinge index, Axis index                         |       |
| AC  |       | Rotor spin axis unit vector x,y,z                              |       |
| AC  |       | Initial rotor momentum, H                                      |       |
| AC  |       | Outer gimbal- angle(deg), inertia, friction(D,S,B,N)           |       |
|     |       |                                                                |       |
| AC  |       | Outer gimbal axis unit vector x,y,z                            |       |
| AC  |       | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) |       |
| AC  |       | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)        |       |
| AC  |       | Inner gimbal axis unit vector x,y,z                            |       |
| AC  |       | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)              |       |
| AC  | 20    | Initial length and rate, y(to) and ydot(to)                    |       |
| AC  | 20    | Constants; K1 or wo, n or zeta, Kg, Jm                         |       |
| AC  |       | Non-linearities; TLim, Tco, Dz                                 |       |
|     |       |                                                                |       |
| AC  | 21    | Actuator ID number                                             | 21    |
|     |       |                                                                | MO    |
| AC  |       | Type (J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                           | 110   |
| AC  |       | Actuator location; Node or Hinge (N or H)                      | 1 2   |
| AC  |       | Mounting point body ID number, node ID number                  | 1 4   |
| AC  | 21    | Second mounting point body ID, second node ID                  |       |
|     |       |                                                                |       |

| AC                                                                              | 21 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0 1 0        |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |
| AC                                                                              | 21 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | •            |
| AC                                                                              | 21 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| AC                                                                              | <pre>21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |
| AC                                                                              | 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| AC                                                                              | 21 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
| AC                                                                              | 21 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |
| AC                                                                              | 21 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |
| AC                                                                              | 21 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |              |
| AC                                                                              | 22 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 22           |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MO           |
| AC                                                                              | 22 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1 2          |
| AC                                                                              | 22 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| AC                                                                              | 22 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0 0 1        |
| AC                                                                              | 22 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |
| AC                                                                              | 22 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| AC                                                                              | 22 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| AC                                                                              | <pre>22 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| AC                                                                              | 22 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |
| AC                                                                              | 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| AC                                                                              | 22 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |
| AC                                                                              | 22 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |
| AC                                                                              | 22 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| AC                                                                              | 22 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| AC<br>AC                                                                        | 22 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |
|                                                                                 | 22 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |              |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 23           |
| AC                                                                              | 23 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 23<br>MA     |
| AC<br>AC                                                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 23<br>MA     |
| AC<br>AC<br>AC                                                                  | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |
| AC<br>AC<br>AC<br>AC                                                            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MA           |
| AC<br>AC<br>AC                                                                  | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MA           |
| AC<br>AC<br>AC<br>AC                                                            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC                                                      | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 24 Initial rotor momentum, H 25 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 23 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 24 Outer gimbal axis unit vector x,y,z 25 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 24 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 25 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 24 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 25 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 26 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | MA<br>1 2    |
| AC A                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 24 Outer gimbal axis unit vector x,y,z 25 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 26 Inner gimbal axis unit vector x,y,z 27 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 23 Outer gimbal axis unit vector x,y,z 23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 24 Inner gimbal axis unit vector x,y,z 25 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 26 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Initial rotor momentum, H 27 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 23 Outer gimbal axis unit vector x,y,z 23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 24 Inner gimbal axis unit vector x,y,z 25 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 26 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Initial rotor momentum, H 27 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MA<br>1 2    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC      | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 24 Rotor spin axis unit vector x,y,z 25 Initial rotor momentum, H 26 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 27 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Initial length and rate, y(to) and ydot(to) 23 Constants; K1 or wo, n or zeta, Kg, Jm 24 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 23 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 23 Outer gimbal axis unit vector x,y,z 23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 24 Inner gimbal axis unit vector x,y,z 25 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 26 Initial length and rate, y(to) and ydot(to) 27 Constants; K1 or wo, n or zeta, Kg, Jm 28 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 23 Mounting point Hinge index, Axis index 24 Rotor spin axis unit vector x,y,z 25 Initial rotor momentum, H 26 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 27 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 22 Non-linearities; TLim, Tco, Dz 23 Actuator ID number 24 Actuator ID number 24 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 24 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index 26 Rotor spin axis unit vector x,y,z 27 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 29 Outer gimbal axis unit vector x,y,z 20 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MA 1 2 1 0 0 |
| AC A                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Initial rotor momentum, H 27 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 29 Mounting point body ID number, node ID number 20 Second mounting point body ID, second node ID 20 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MA 1 2 1 0 0 |
| AC A                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Initial rotor momentum, H 27 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 29 Mounting point body ID number, node ID number 20 Second mounting point body ID, second node ID 20 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MA 1 2 1 0 0 |
| AC A                                        | 23 Actuator ID number 23 Type (J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Initial rotor momentum, H 27 Outer gimbal - angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Initial length and rate, y(to) and ydot(to) 23 Constants; K1 or wo, n or zeta, Kg, Jm 24 Actuator ID number 25 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 26 Actuator Iocation; Node or Hinge (N or H) 27 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 29 Output axis unit vector x,y,z 20 Mounting point Hinge index, Axis index 20 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MA 1 2 1 0 0 |
| AC A                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 24 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index 26 Rotor spin axis unit vector x,y,z 27 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 29 Outer gimbal axis unit vector x,y,z 20 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 29 Mounting point body ID number, node ID number 29 Second mounting point body ID, second node ID 20 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 22 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                          | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 24 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index 26 Rotor spin axis unit vector x,y,z 27 Initial rotor momentum, H 27 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal- axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 29 Mounting point body ID number, node ID number 29 Second mounting point body ID, second node ID 20 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 22 Rotor spin axis unit vector x,y,z 23 Initial rotor momentum, H 24 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                      | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 24 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index 26 Rotor spin axis unit vector x,y,z 27 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 29 Outer gimbal axis unit vector x,y,z 20 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(M,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(M,M,B,k) 23 Inner gimbal axis unit vector x,y,z 24 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(M,M,B,k) 25 Initial length and rate, y(to) and ydot(to) 26 Constants; K1 or wo, n or zeta, Kg, Jm 27 Non-linearities; TLim, Tco, Dz 28 Actuator ID number 29 Actuator ID number 29 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 20 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 22 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z 24 Mounting point Hinge index, Axis index 25 Rotor spin axis unit vector x,y,z 26 Mounting point Hinge index, Axis index 27 Actuator gimbal angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                            | MA 1 2 1 0 0 |
| AC A                                        | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Outer gimbal axis unit vector x,y,z  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal axis unit vector x,y,z  In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Initial length and rate, y(to) and ydot(to)  Constants; Kl or wo, n or zeta, Kg, Jm  Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Outer gimbal axis unit vector x,y,z  Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                 | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Coutput axis unit vector x,y,z  Mounting point Hinge index, Axis index  Initial rotor momentum, H  Couter gimbal- angle(deg), inertia, friction(D,S,B,N)  Couter gimbal axis unit vector x,y,z  Inner gimbal- angle(deg), inertia, friction(D,S,B,N)  Inner gimbal- angle(deg), inertia, friction(D,S,B,N)  Inner gimbal- axis unit vector x,y,z  Inner gimbal- axis unit vector x,y,z  Ingim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Initial length axis unit vector x,y,z  Initial length and rate, y(to) and ydot(to)  Constants; K1 or wo, n or zeta, Kg, Jm  Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg), inertia, friction(D,S,B,N)  Uter gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                            | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Coutput axis unit vector x,y,z  Mounting point Hinge index, Axis index  Initial rotor momentum, H  Couter gimbal axis unit vector x,y,z  Inter gimbal axis unit vector x,y,z  Inter gimbal axis unit vector x,y,z  Inter gimbal axis unit vector x,y,z  Index gimbal axis unit vector x,y,z  Inter gimbal axis unit vector x,y,z  Inter gimbal axis unit vector x,y,z  Ingim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Inner gimbal axis unit vector x,y,z  Ingim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Initial length and rate, y(to) and ydot(to)  Constants; K1 or wo, n or zeta, Kg, Jm  Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal axis unit vector x,y,z  Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Inner gimbal axis unit vector x,y,z  Inner gimbal axis unit vector x,y,z                                                                                                                                                                                      | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Mutput axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Inter gimbal axis unit vector x,y,z  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal axis unit vector x,y,z  In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Initial length and rate, y(to) and ydot(to)  Constants; K1 or wo, n or zeta, Kg, Jm  Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal axis unit vector x,y,z  Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Inner gimbal axis unit vector x,y,z  In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                  | MA 1 2 1 0 0 |
| AC A                                        | 23 Actuator ID number 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 23 Actuator location; Node or Hinge (N or H) 23 Mounting point body ID number, node ID number 23 Second mounting point body ID, second node ID 24 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index 26 Rotor spin axis unit vector x,y,z 27 Initial rotor momentum, H 27 Outer gimbal - angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal - angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz 26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 29 Mounting point body ID number, node ID number 29 Second mounting point body ID, second node ID 20 Output axis unit vector x,y,z 21 Initial rotor momentum, H 22 Outer gimbal - angle(deg), inertia, friction(D,S,B,N) 23 Outer gimbal axis unit vector x,y,z 24 Initial rotor momentum, H 25 Outer gimbal axis unit vector x,y,z 26 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 27 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) | MA 1 2 1 0 0 |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Mutput axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Inter gimbal axis unit vector x,y,z  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal axis unit vector x,y,z  In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Initial length and rate, y(to) and ydot(to)  Constants; K1 or wo, n or zeta, Kg, Jm  Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)  Mounting point body ID number, node ID number  Second mounting point body ID, second node ID  Output axis unit vector x,y,z  Mounting point Hinge index, Axis index  Rotor spin axis unit vector x,y,z  Initial rotor momentum, H  Outer gimbal- angle(deg),inertia,friction(D,S,B,N)  Inner gimbal axis unit vector x,y,z  Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)  Inner gimbal axis unit vector x,y,z  In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                  | MA 1 2 1 0 0 |

| AC |    | Actuator ID number                                                 | 25    |
|----|----|--------------------------------------------------------------------|-------|
| AC |    | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                | MA    |
| AC |    | Actuator location: Node or Hinge (N or H)                          |       |
| AC |    | Mounting point body ID number, node ID number                      | 1 2   |
| AÇ |    | Second mounting point body ID, second node ID                      |       |
| AC |    | Output axis unit vector x,y,z                                      | 001   |
| AC | 25 | Mounting point Hinge index, Axis index                             |       |
| AC | 25 | Rotor spin axis unit vector x,y,z                                  |       |
| AC | 25 | Initial rotor momentum, H                                          |       |
| AÇ | 25 | Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                 |       |
| AC | 25 | Outer gimbal axis unit vector x,y,z                                |       |
| AC | 25 | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                 |       |
| AC | 25 | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)            |       |
| AC | 25 | Inner gimbal axis unit vector x,y,z                                |       |
| AC | 25 | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)      |       |
| AC | 25 | Initial length and rate, y(to) and ydot(to)                        |       |
| AC | 25 | Constants; K1 or wo, n or zeta, Kg, Jm                             |       |
| AC | 25 | Non-linearities; TLim, Tco, Dz                                     |       |
|    |    |                                                                    |       |
| AC | 26 | Actuator ID number                                                 | 26    |
| AC | 26 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                | J     |
| AC | 26 | Actuator location; Node or Hinge (N or H)                          |       |
| AC | 26 | Mounting point body ID number, node ID number                      | 3 2   |
| AC |    | Second mounting point body ID, second node ID                      |       |
| AC |    | Output axis unit vector x,y,z                                      | 100   |
| AC |    | Mounting point Hinge index, Axis index                             |       |
| AC |    | Rotor spin axis unit vector x,y,z                                  |       |
| AC |    | Initial rotor momentum, H                                          |       |
| AC |    | Outer gimbal - angle(deg), inertia, friction(D, S, B, N)           |       |
| AC |    | Outer gimbal axis unit vector x,y,z                                |       |
| AC |    | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)     |       |
| AC |    | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)            |       |
| AC |    | Inner gimbal axis unit vector x,y,z                                |       |
| AC | 26 | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                  |       |
| AC |    | Initial length and rate, y(to) and ydot(to)                        |       |
| AC |    | Constants; K1 or wo, n or zeta, Kg, Jm                             |       |
| AC |    | Non-linearities; TLim, Tco, Dz                                     |       |
|    |    | 101 1110 110 110 110 110 110 110 110 11                            |       |
| AC | 27 | Actuator ID number                                                 | 27    |
| AC |    | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                | J     |
| AC |    | Actuator location; Node or Hinge (N or H)                          | _     |
| AC |    | Mounting point body ID number, node ID number                      | 3 2   |
| AC |    | Second mounting point body ID, second node ID                      |       |
| AC |    | Output axis unit vector x,y,z                                      | 010   |
| AC |    | Mounting point Hinge index, Axis index                             |       |
| AC |    | Rotor spin axis unit vector x,y,z                                  |       |
| AC |    | Initial rotor momentum, H                                          |       |
| AC |    | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)            |       |
| AC |    | Outer gimbal axis unit vector x,y,z                                |       |
| AC |    | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                 |       |
| AC | 27 | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre> |       |
| AC | 27 | Inner gimbal axis unit vector x,y,z                                |       |
| AC |    | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                  |       |
| AC | 27 | Initial length and rate, y(to) and ydot(to)                        |       |
| AC |    | Constants; K1 or wo, n or zeta, Kg, Jm                             |       |
| AC |    | Non-linearities; TLim, Tco, Dz                                     |       |
|    |    |                                                                    |       |
| AC | 28 | Actuator ID number                                                 | 28    |
| AC | 28 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                | J     |
| AC |    | Actuator location; Node or Hinge (N or H)                          |       |
| AC |    | Mounting point body ID number, node ID number                      | 3 2   |
| AC |    | Second mounting point body ID, second node ID                      |       |
| AC |    | Output axis unit vector x, y, z                                    | 0 0 1 |
| AC |    | Mounting point Hinge index, Axis index                             |       |
| AC |    | Rotor spin axis unit vector x,y,z                                  |       |
| AC |    | Initial rotor momentum, H                                          |       |
| AC |    | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)            |       |
| AC |    | Outer gimbal axis unit vector x,y,z                                |       |
| AC |    | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                 |       |
| AC |    | Inner gimbal- angle (deg), inertia, friction (D, S, B, N)          |       |
| AC |    | Inner gimbal axis unit vector x,y,z                                |       |
|    | -  | — · · · · · · · · · · · · · · · · · · ·                            |       |

| AC       | 28 | <pre>In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                 |            |
|----------|----|----------------------------------------------------------------------------------------------|------------|
| AC       |    | Initial length and rate, y(to) and ydot(to)                                                  |            |
| AC       |    | Constants; K1 or wo, n or zeta, Kg, Jm                                                       |            |
| AC       |    | Non-linearities; TLim, Tco, Dz                                                               |            |
|          |    |                                                                                              |            |
|          |    | CONTROLLER                                                                                   |            |
|          |    |                                                                                              |            |
|          |    |                                                                                              | _          |
| CO       |    | Controller ID number                                                                         | 1          |
| CO       |    | Controller type (CB,CM,DB,DM,UC,UD)                                                          | UD<br>0.10 |
| CO<br>CO |    | Sample time (sec) Number of inputs, Number of outputs                                        | 21 16      |
| co       |    | Number of states                                                                             | 21 10      |
| CO       |    | Output No., Input type (I,S,T), Input ID, Gain                                               |            |
|          | _  | output No., input type (1/0/1/) imput ib/ cam                                                |            |
| CO       | 2  | Controller ID number                                                                         | 2          |
| CO       |    | Controller type (CB,CM,DB,DM,UC,UD)                                                          | UC         |
| CO       |    | Sample time (sec)                                                                            |            |
| CO       | 2  | Number of inputs, Number of outputs                                                          | 6,6        |
| CO       | 2  | Number of states                                                                             | 0          |
| CO       | 2  | Output No., Input type (I,S,T), Input ID, Gain                                               |            |
|          |    |                                                                                              |            |
|          |    | INTERCONNECT                                                                                 |            |
|          |    |                                                                                              |            |
| IN       | 1  | Interconnect ID number                                                                       | 1          |
| IN       |    | Source type(S,C, or F), Source ID, Source row #                                              | C 1 1      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 1 1      |
| IN       |    | Gain                                                                                         | 1          |
|          | _  |                                                                                              |            |
| IN       | 2  | Interconnect ID number                                                                       | 2          |
| IN       | 2  | Source type(S,C, or F), Source ID, Source row #                                              | C 1 2      |
| IN       | 2  | Destination type(A or C), Dest ID, Dest row #                                                | A 2 1      |
| IN       | 2  | Gain                                                                                         | 1          |
|          |    |                                                                                              |            |
| IN       |    | Interconnect ID number                                                                       | 3          |
| IN       |    | Source type(S,C, or F), Source ID, Source row #                                              | C 1 3      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 3 1<br>1 |
| IN       | 3  | Gain                                                                                         | 1          |
| IN       | 4  | Interconnect ID number                                                                       | 4          |
| IN       |    | Source type(S,C, or F), Source ID, Source row #                                              | C 1 4      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 4 1      |
| IN       | 4  | Gain                                                                                         | 1          |
|          |    |                                                                                              |            |
| IN       |    | Interconnect ID number                                                                       | 5          |
| IN       |    | Source type(S,C, or F), Source ID, Source row #                                              | C 1 5      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 5 1      |
| IN       | 9  | Gain                                                                                         | 1          |
| IN       | 6  | Interconnect ID number                                                                       | 6          |
| IN       |    | Source type(S,C, or F),Source ID,Source row #                                                | C 1 6      |
| IN       | 6  | Destination type(A or C), Dest ID, Dest row #                                                | A 6 1      |
| IN       |    | Gain                                                                                         | 1          |
|          | -  |                                                                                              |            |
| IN       |    | Interconnect ID number                                                                       | 7          |
| IN       |    | Source type(S,C, or F),Source ID,Source row #                                                | C 1 7      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 7 1      |
| IN       | 7  | Gain                                                                                         | 1          |
|          | _  | Tabanasan TD mumber                                                                          | o          |
| IN       |    | Interconnect ID number                                                                       | 8<br>C 1 8 |
| IN       |    | Source type(S,C, or F), Source ID, Source row # Postination type(A) or C) Post ID Post row # | A 8 1      |
| IN       |    | Destination type(A or C),Dest ID,Dest row #                                                  | 1          |
| IN       | đ  | Gain                                                                                         | -          |
| IN       | q  | Interconnect ID number                                                                       | 9          |
| IN       |    | Source type(S,C, or F),Source ID,Source row #                                                | C 1 9      |
| IN       |    | Destination type(A or C), Dest ID, Dest row #                                                | A 9 1      |
| IN       |    | Gain                                                                                         | 1          |
|          |    |                                                                                              |            |
| IN       | 10 | Interconnect ID number                                                                       | 10         |
|          |    |                                                                                              |            |

| IN<br>IN       | 10 Destination type(A or C), Dest ID, Dest row #                                                                                      | C 1 10<br>A 10 1<br>1       |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| IN<br>IN<br>IN | <pre>11 Source type(S,C, or F),Source ID,Source row # 11 Destination type(A or C),Dest ID,Dest row #</pre>                            | 11<br>C 1 11<br>A 11 1<br>1 |
| IN<br>IN<br>IN | 12 Source type(S,C, or F),Source ID,Source row # 12 Destination type(A or C),Dest ID,Dest row #                                       | 12<br>C 1 12<br>A 12 1<br>1 |
| IN<br>IN<br>IN | <pre>13 Source type(S,C, or F),Source ID,Source row # 13 Destination type(A or C),Dest ID,Dest row #</pre>                            | 13<br>C 1 13<br>A 13 1      |
| IN<br>IN<br>IN | 14 Source type(S,C, or F),Source ID,Source row # 14 Destination type(A or C),Dest ID,Dest row #                                       | 14<br>C 1 14<br>A 14 1<br>1 |
| IN<br>IN<br>IN | 15 Source type(S,C, or F),Source ID,Source row # 15 Destination type(A or C),Dest ID,Dest row #                                       | 15<br>C 1 15<br>A 15 1<br>1 |
| IN<br>IN<br>IN | 16 Source type(S,C, or F),Source ID,Source row # 16 Destination type(A or C),Dest ID,Dest row #                                       | 16<br>C 1 16<br>A 16 1<br>1 |
| IN<br>IN<br>IN | 26 Source type(S,C, or F), Source ID, Source row #                                                                                    | 26<br>S 1 1<br>C 1 1<br>1   |
| IN<br>IN<br>IN | 27 Source type(S,C, or F), Source ID, Source row #                                                                                    | 27<br>S 2 1<br>C 1 2<br>1   |
| IN<br>IN<br>IN | 28 Interconnect ID number 28 Source type(S,C, or F),Source ID,Source row # 28 Destination type(A or C),Dest ID,Dest row # 28 Gain     | 28<br>S 3 1<br>C 1 3        |
| IN<br>IN<br>IN | 29 Interconnect ID number 29 Source type(S,C, or F),Source ID,Source row # 29 Destination type(A or C),Dest ID,Dest row # 29 Gain     | 29<br>S 4 1<br>C 1 4<br>1   |
| IN<br>IN<br>IN | 30 Interconnect ID number 30 Source type(S,C, or F), Source ID, Source row # 30 Destination type(A or C), Dest ID, Dest row # 30 Gain | 30<br>S 4 2<br>C 1 5        |
| IN<br>IN<br>IN | 31 Interconnect ID number 31 Source type(S,C, or F), Source ID, Source row # 31 Destination type(A or C), Dest ID, Dest row # 31 Gain | 31<br>S 5 1<br>C 1 6<br>1   |
| IN<br>IN<br>IN | 32 Interconnect ID number 32 Source type(S,C, or F), Source ID, Source row # 32 Destination type(A or C), Dest ID, Dest row # 32 Gain | 32<br>S 5 2<br>C 1 7        |
| IN<br>IN       | 33 Interconnect ID number 33 Source type(S,C, or F),Source ID,Source row #                                                            | 33<br>s 5 3                 |

| IN<br>IN       |                                                                                                              | ŧ | C 1 8                      |
|----------------|--------------------------------------------------------------------------------------------------------------|---|----------------------------|
| IN<br>IN<br>IN | N 34 Source type(S,C, or F),Source ID,Source row<br>N 34 Destination type(A or C),Dest ID,Dest row #         |   | 34<br>S 6 1<br>C 1 9       |
| IN<br>IN<br>IN | N 35 Source type(S,C, or F),Source ID,Source row<br>N 35 Destination type(A or C),Dest ID,Dest row #         |   | 35<br>S 7 1<br>C 1 10<br>1 |
| IN<br>IN<br>IN | N 36 Source type(S,C, or F),Source ID,Source row<br>N 36 Destination type(A or C),Dest ID,Dest row #         |   | 36<br>S 8 1<br>C 1 11<br>1 |
| IN<br>IN<br>IN | N 37 Source type(S,C, or F), Source ID, Source row<br>N 37 Destination type(A or C), Dest ID, Dest row #     |   | 37<br>S 9 1<br>C 1 12<br>1 |
| IN<br>IN<br>IN | N 38 Source type(S,C, or F),Source ID,Source row<br>N 38 Destination type(A or C),Dest ID,Dest row #         |   | 38<br>S 10 1<br>C 2 1<br>1 |
| IN<br>IN<br>IN | N 39 Source type(S,C, or F), Source ID, Source row<br>N 39 Destination type(A or C), Dest ID, Dest row #     |   | 39<br>S 10 2<br>C 2 2<br>1 |
| IN<br>IN<br>IN | <pre>40 Source type(S,C, or F),Source ID,Source row 40 Destination type(A or C),Dest ID,Dest row #</pre>     |   | 40<br>s 10 3<br>C 2 3<br>1 |
| IN<br>IN<br>IN | <pre>41 Source type(S,C, or F),Source ID,Source row 41 Destination type(A or C),Dest ID,Dest row #</pre>     |   | 41<br>S 11 1<br>C 2 4<br>1 |
| IN<br>IN<br>IN | <pre>1 42 Source type(S,C, or F),Source ID,Source row 1 42 Destination type(A or C),Dest ID,Dest row #</pre> |   | 42<br>S 11 2<br>C 2 5<br>1 |
| IN<br>IN<br>IN | 43 Source type(S,C, or F),Source ID,Source row 43 Destination type(A or C),Dest ID,Dest row #                |   | 43<br>S 11 3<br>C 2 6<br>1 |
| IN<br>IN<br>IN | 17 Source type(S,C, or F),Source ID,Source row 17 Destination type(A or C),Dest ID,Dest row #                |   | 17<br>C 2 1<br>A 26 1      |
| IN<br>IN<br>IN | 18 Source type(S,C, or F),Source ID,Source row<br>18 Destination type(A or C),Dest ID,Dest row #             |   | 18<br>C 2 2<br>A 27 1      |
| IN<br>IN<br>IN | <pre>19 Source type(S,C, or F),Source ID,Source row 19 Destination type(A or C),Dest ID,Dest row #</pre>     | # | 19<br>C 2 3<br>A 28 1<br>0 |
| IN<br>IN<br>IN | 20 Source type(S,C, or F), Source ID, Source row                                                             | # | 20<br>C 2 4<br>A 23 1      |

| IN       | 20  | Gain                                                                         | 1                |
|----------|-----|------------------------------------------------------------------------------|------------------|
| IN       | 21  | Interconnect ID number                                                       | 21               |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                              | C 2 5            |
| IN       | 21  | Destination type(A or C), Dest ID, Dest row #                                | A 24 1           |
| IN       |     | Gain                                                                         | 1                |
| TRI      | 22  | Interconnect ID number                                                       | 22               |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                              | C 2 6            |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | A 25 1           |
| IN       |     | Gain                                                                         | 1                |
|          |     |                                                                              |                  |
| IN       |     | Interconnect ID number                                                       | 23               |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                              | S 17 1<br>C 1 13 |
| IN<br>IN |     | Destination type(A or C),Dest ID,Dest row # Gain                             | 1                |
| 114      | 23  | Galli                                                                        | *                |
| IN       |     | Interconnect ID number                                                       | 24               |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                              | s 17 2           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 14           |
| IN       | 24  | Gain                                                                         | 1                |
| IN       | 25  | Interconnect ID number                                                       | 25               |
| IN       | 25  | Source type(S,C, or F), Source ID, Source row #                              | s 17 3           |
| IN       | 25  | Destination type(A or C), Dest ID, Dest row #                                | C 1 15           |
| IN       | 25  | Gain                                                                         | 1                |
| TN       | 44  | Interconnect ID number                                                       | 44               |
|          |     | Source type(S,C, or F), Source ID, Source row #                              | S 17 4           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 16           |
| IN       |     | Gain                                                                         | 1                |
| 737      | 4 = | International ID aughor                                                      | 45               |
| IN       |     | Interconnect ID number Source type(S,C, or F),Source ID,Source row #         | S 17 5           |
|          |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 17           |
| IN       |     | Gain                                                                         | 1                |
| 114      |     | Cult                                                                         | _                |
|          |     | Interconnect ID number                                                       | 46               |
|          |     | Source type(S,C, or F), Source ID, Source row #                              | S 17 6           |
|          |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 18           |
| IN       | 40  | Gain                                                                         | 1                |
| IN       | 47  | Interconnect ID number                                                       | 47               |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                              | s 17 7           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 19           |
| IN       | 47  | Gain                                                                         | 1                |
| IN       | 48  | Interconnect ID number                                                       | 48               |
| IN       | 48  | Source type(S,C, or F), Source ID, Source row #                              | S 17 8           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 20           |
| IN       | 48  | Gain                                                                         | 1                |
| IN       |     | Interconnect ID number                                                       | 49               |
| IN       | 49  | Source type(S,C, or F), Source ID, Source row #                              | S 17 9           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                | C 1 21           |
| IN       | 49  | Gain                                                                         | 1                |
|          |     | AEROD                                                                        |                  |
|          |     |                                                                              |                  |
| AE       | 1   | Aerodynamic Model ID #                                                       | 1                |
| AE       |     | Body ID, Center of Pressure Node ID                                          | 1 13             |
| AE       | 1   | Atmosphere Type (C,J,M)                                                      | J                |
| ΑE       |     | Constant Density for Atmosphere Type=C                                       | _                |
| ΑE       |     | Model Type (P,C,T,B)                                                         | T                |
| AE       |     | Dimensions D,L (meters)                                                      |                  |
| AE<br>NE |     | Unit Normal Vector X,y,z                                                     | 16.6051 2.2990   |
| AE<br>AE |     | Aero Ref Area, Ref Length (meters) Name of Aero Coefficient Table Input File | .\newttae.dat    |
| AE       |     | Axial unit vector in body (alpha=0,phi=0)                                    | 0. 0. 1.         |
| ΑE       |     | Vert unit vector in body (alpha=90,phi=0)                                    | .70717071 0.     |
|          |     |                                                                              |                  |

bd Systems® TCD20030028A

AE 1 Horiz unit vector in body (alpha=90,phi=90)

Date: 14 February 2003 Contract No.: NAS8-00114

.7071 .7071 0.

## Appendix B

## USER CONTINUOUS AND DISCRETE CONTROL LERS AUXILIARY SUBROUTINES UCONTROL.FOR

```
C File Name: USCC.FOR
   Description: User continuous controllers to be used with Treetops
    U : controller inputs (sensors)
   R : controller outputs (actuators)
C
        u(1) = relative inertial position (x) from spacecraft to SG#2
C
        u(2) = relative inertial position (y) from spacecraft to SG#2
C
        u(3) = relative inertial position (z) from spacecraft to SG#2
C
        u(4) = relative inertial velocity (x) from spacecraft to SG#2
C
        u(5) = relative inertial velocity (y) from spacecraft to SG#2
        u(6) = relative inertial velocity (z) from spacecraft to SG#2
       r(1-3) = SG#2 Suspension Force Commands (N)
       r(4-6) = Cryoperm shield induced magnetic moment torque (N-m)
(***********************************
        SUBROUTINE USCC(KRKPAS, T, U, X, R, XDOT)
        IMPLICIT NONE
        include 'DBP.F'
        include 'DBB.F'
        include 'DBSP.F'
        INTEGER*4 KRKPAS,I
        REAL*8 T, XDOT(3), U(6), R(6), X(6)
        real*8 usus(3),psus(3),vsus(3),psg2i_ix,psg2i_iy,psg2i_iz
        real*8 psg2i(3),psg2b(3),vsg2i(3),vsg2b(3),KSUS1,KSUS2,usat
        real*8 mmom(3), bmagb(3)
        real*8 dto,Told,L1,L2,x1o(3),x1o_o(3),x2o(3),x2o_o(3),psus_o(3)
        logical first_pass
        data first_pass / .true. /
        if (first_pass) then
          first_pass = .false.
          psg2i_ix = u(1)
psg2i_iy = u(2)
          psg2i_iz = u(3)
        endif
CSUS
  For gyro suspension, convert the relative position and velocity from
   spacecraft to SG#2 from inertial to body coordinates and apply noise
   and quantization
     Position
       psg2i(1) = u(1) - psg2i_ix

psg2i(2) = u(2) - psg2i_iy
        psg2i(3) = u(3) - psg2i_iz
        call intobo (psg2i,psg2b,1) !jrg uses ctrans for body 1
CASH
  No noise on position sensors right now
C
       psus(1) = psg2b(1) + RNORM (seed_dfx, std_dfs, 0.0D0)
       psus(2) = psg2b(2) + RNORM (seed_dfy, std_dfs, 0.0D0)

psus(3) = psg2b(3) + RNORM (seed_dfz, std_dfs, 0.0D0)
С
C
С
       psus(1) = ORDQUAN(psus(1),lsb_dfs)
С
       psus(2) = ORDQUAN(psus(2),lsb_dfs)
       psus(3) = ORDQUAN(psus(3),1sb_dfs)
       psus(1) = psg2b(1)
       psus(2) = psg2b(2)
       psus(3) = psg2b(3)
```

```
С
cash
   Observer from dissertation
C
C
       L1 = 0.539d0
       L2 = 17.26d0
       dto = T - Told
       Told = T
С
       x10(1) =
     x10_0(1)+dto*x20_0(1)+dto*dto/2.d0*usus(1)+L1*(psus_0(1)-x10_0(1))
     &x10_0(2)+dto*x20_0(2)+dto*dto/2.d0*usus(2)+L1*(psus_0(2)-x10_0(2))
       x1o(3) =
     x10_0(3)+dto*x20_0(3)+dto*dto/2.d0*usus(3)+L1*(psus_0(3)-x10_0(3))
       x2o(1) = x2o_0(1) + dto*usus(1) + L2*(psus_0(1) - x1o_0(1))
       x2o(2) = x2o_o(2) + dto*usus(2) + L2*(psus_o(2) - x1o_o(2))
       x2o(3) = x2o_o(3) + dto*usus(3) + L2*(psus_o(3) - x1o_o(3))
С
       x10_0(1) = x10(1)
       x1o_0(2) = x1o(2)
       x10_0(3) = x10(3)
       x2o_0(1) = x2o(1)
        x2o_0(2) = x2o(2)
       x2o_0(3) = x2o(3)
        psus_o(1) = psus(1)
        psus_o(2) = psus(2)
        psus_o(3) = psus(3)
cash
С
     Velocity
        vsg2i(1) = u(4)
        vsg2i(2) = u(5)
        vsg2i(3) = u(6)
        call intobo (vsg2i, vsg2b, 1)
   No sensor errors right now
       vsus(1) = vsg2b(1) + RNORM (seed_dfx, std_dfs, 0.0D0)
C
       vsus(2) = vsg2b(2) + RNORM (seed_dfy, std_dfs, 0.0D0)
       vsus(3) = vsg2b(3) + RNORM (seed_dfz, std_dfs, 0.0D0)
C
       vsus(1) = ORDQUAN(vsus(1),lsb_dfs)
С
       vsus(2) = ORDQUAN(vsus(2), lsb_dfs)
C
       vsus(3) = ORDQUAN(vsus(3),1sb_dfs)
        vsus(1) = vsg2b(1)
        vsus(2) = vsg2b(2)
        vsus(3) = vsg2b(3)
                            SUSPENSION CONTROL ***************
C***************
CSUS Gain switching logic
       if ( ) then
C
           KSUS1 = 1.5D8
           KSUS2 = 4.2D6
          usat = 9.81d-4
                             ! 1.d-4 g's
С
       elseif ( ) then
          KSUS1 =
C
C
          KSUS2 =
C
       endif
   below is for perfect position, velocity, not observer inputs
С
       usus(1) = -psus(1) \cdot (1.d0 + KSUS1 \cdot dabs(psus(1)))
                 - vsus(1)*(1.4d0 + KSUS2*dabs(vsus(1)))
      &
C
       usus(2) = -psus(2)*(1.d0 + KSUS1*dabs(psus(2)))
C
                 - vsus(2)*(1.4d0 + KSUS2*dabs(vsus(2)))
C
       usus(3) = -psus(3)*(1.d0 + KSUS1*dabs(psus(3)))
С
                  - vsus(3)*(1.4d0 + KSUS2*dabs(vsus(3)))
C
C
cash
c below uses observer inputs
```

usus(1) = -xlo(1)\*(1.d0 + KSUS1\*dabs(xlo(1)))- x2o(1)\*(1.4d0 + KSUS2\*dabs(x2o(1)))usus(2) = -x1o(2)\*(1.d0 + KSUS1\*dabs(x1o(2)))- x2o(2)\*(1.4d0 + KSUS2\*dabs(x2o(2)))usus(3) = -x1o(3)\*(1.d0 + KSUS1\*dabs(x1o(3)))- x2o(3)\*(1.4d0 + KSUS2\*dabs(x2o(3)))cash C CSUS Send the suspension forces to output observer requirements assumes that u is specific force (acc) usus(1) = dsign(dmin1(dabs(usus(1)),usat),usus(1)) usus(2) = dsign(dmin1(dabs(usus(2)),usat),usus(2)) usus(3) = dsign(dmin1(dabs(usus(3)),usat),usus(3)) r(1) = usus(1)\*BMASS(3)r(2) = usus(2)\*BMASS(3)r(3) = usus(3)\*BMASS(3)r(1) = dsign(dmin1(dabs(usus(1)),usat),usus(1)) cash assume u is force r(2) = dsign(dmin1(dabs(usus(2)),usat),usus(2)) cash assume u is force r(3) = dsign(dmin1(dabs(usus(3)),usat),usus(3)) cash assume u is force r(1) = 0.d0C r(2) = 0.d0C С r(3) = 0.d0С if (icount .lt. iplot) then icount = icount + 1 С C return endif С icount = 1 C C write(16) T, (u(i), i=1, 6), & (psus(i), i=1,3), (vsus(i), i=1,3),C & (r(i), i=1,3), (usus(i), i=1,3), (psg2i(i), i=1,3), (vsg2i(i), i=1,3)С nrows = nrows + 1С call adj\_msiz(ncols,nrows,16,hdrpos,wtflg) C Cryoperm shield torque Transform B to body 1 frame bmagb(1) = ctrans(1,1,1)\*bmagi(1)+ ctrans(2,1,1)\*bmagi(2) + ctrans(3,1,1)\*bmagi(3) bmagb(2) = ctrans(1,2,1)\*bmagi(1)+ ctrans(2,2,1)\*bmagi(2) + ctrans(3,2,1)\*bmagi(3) bmagb(3) = ctrans(1,3,1)\*bmagi(1)+ ctrans(2,3,1)\*bmagi(2) + ctrans(3,3,1)\*bmagi(3) 1 mmom(1) = 1.7632D5\*bmagb(1)mmom(2) = 1.6032D5\*bmagb(2)mmom(3) = 2.1600D6\*bmagb(3)do i=1.3r(3+i) = ctrans(i,1,1)\*mmom(1) + ctrans(i,2,1)\*mmom(2) +ctrans(i, 3, 1) \*mmom(3) enddo return end \*\*\*\*\*\*\*\*\*\*\* This is a user defined DOUBLE PRECISION discrete controller subroutine C Inputs: u(1) = roll rate from rate gyro (rad/sec) C u(2) = pitch rate from rate gyro (rad/sec) u(3) = yaw rate from rate gyro (rad/sec) u(4) = pitch error angle from science telescope (ST) C u(5) = yaw error angle from science telescope (ST) u(6) = relative inertial position (x) from spacecraft to SG#1 u(7) = relative inertial position (y) from spacecraft to SG#1 u(8) = relative inertial position (z) from spacecraft to SG#1 u(9) = SG#1 acceleration X (body) C u(10) = SG#1 acceleration Y (body) C u(11) = SG#1 acceleration Z (body) C u(12) = roll angle from integrating rate gyro (rad)

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С u(13) ... u(21) 9 elements of LVLH-to-body matrix C С Outputs: С r(1-16) =Sixteen Thruster Forces (N) С r(17-19) = disturbance forces at cg (N)C r(20-22) = disturbance torques at cg (N-M)r(23-25) =Three Magnetic Torquer Bar Commands (A-m^2) SUBROUTINE USDC (TIME, U, R) implicit none ! double precision (a-h,o-z) CSUS real\*8 TIME, U(12), R(25) real\*8 TIME, U(36), R(16) include 'DBP.F' include 'DBSP.F' include 'DBS.F' include 'DBB.F' include 'RSTRT.F' include 'XFRM.F' logical init, RV real\*8 dtcont,thrctrl,r\_mflow,rnorm C Earth orbit rate and commanded vehicle roll rate real\*8 w\_orbit, w\_roll common / rates / w\_orbit, w\_roll C Attitude control variables real\*8 phi(5), theta(5), psi(5) real\*8 uf\_pit(3), uf\_yaw(3), rf\_pit(3), rf\_yaw(3)
real\*8 uf\_rol(3), rf\_rol(3) real\*8 phi\_c, phi\_a,n\_r\_revs real\*8 Kpy\_rv(5), limpy\_rv(8), Ipy real\*8 Kroll(5), limroll(8), Iroll common / attcont / Kpy\_rv, limpy\_rv, Ipy, Kroll, limroll, Iroll C Translational control variables real\*8 x(3), y(3), z(3)real\*8 uf\_x(3), uf\_y(3), uf\_z(3), rf\_x(3), rf\_y(3), rf\_z(3) real\*8 f\_na(3), f\_bo(3), bona(3,3) real\*8 K\_trans(3), lim\_trans(2), m\_trans common / transcon / K\_trans, lim\_trans, m\_trans C Quaternion Propagation variables real\*8 w\_act(3), a\_err(3), w\_errx(3), a\_act(3) C Scienge Gyro position (inertial, body, nadir) real\*8 psgli(3), psglb(3), psgln(3)
real\*8 da\_ns(4), da\_ew(4) cash integ common / testint / da\_ns,da\_ew cash integ C Sensor signals (Science Telescope, Roll Star Tracker, Control Gyro, and Drag Free Sensor) real\*8 st\_roll, st\_pitch, st\_yaw real\*8 cg\_roll, cg\_pitch, cg\_yaw, cgi\_pitch, cgi\_yaw real\*8 dfs(3) C Environmental Disturbance On Flags & closed loop controller on flag logical GG\_ON, CRYO\_ON, VAB\_ON, CLOSED\_LOOP common / env\_flag / GG\_ON, CRYO\_ON, VAB\_ON, CLOSED\_LOOP C Sensor & actuator disturbance input data C (seeds, standard deviations, least significant bit weights, drifts) integer seed\_str, seed\_stp, seed\_sty integer seed\_cgr, seed\_cgp, seed\_cgy integer seed\_dfx, seed\_dfy, seed\_dfz integer seed\_thr(16), seedthr integer i,mplot,nplot real\*8 std\_str, std\_sct, std\_cg, std\_dfs, std\_thr

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real\*8 lsb\_str, lsb\_sct, lsb\_cgr, lsb\_cgpy, lsb\_dfs, lsb\_thr real\*8 mean\_cgr, mean\_cgp, mean\_cgy cjrg These commons are only used within user controllers common / disturb1 / seed\_thr, seed\_dfx, seed\_dfy, seed\_dfz, seed\_str, seed\_stp, seed\_sty, seed\_cgr, seed\_cgp, seed\_cgy common / disturb2 / std\_str, std\_sct, std\_cg, std\_dfs, std\_thr,
lsb\_str, lsb\_sct, lsb\_cgr, lsb\_cgpy, lsb\_dfs, lsb\_thr, mean\_cgr, mean\_cgp, mean\_cgy C Commanded forces, torques, flow real\*8 tcom(3),tcom\_ff(3),tcryo\_ff(3),t\_sp\_gg(3),f\_sp\_gg(3)  $real*8 t_j2_gg(3), f_j2_gg(3), thrust(16), f(7)$ real\*8 mdot, thrtot C Constants real\*8 pi\_loc, arcrad, radarc parameter (pi\_loc = 3.1415926535897932384d0) parameter (arcrad = pi\_loc / (180.0d0\*3600.0d0)) parameter (radarc = 1.0d0 / arcrad) C Thruster model variables real\*8 Thys(2), thsave(16), th\_delay(16) real\*8 Th, Tl, Tmax common / thrhys1 / Th, Tl, Tmax C Magnetic torquer variables and magnetic field vector real\*8 bb(3) real\*8 Mh, Mmax common / maghys1 / Mh, Mmax real\*8 bbxtcom(3), bbmag2 C real\*8 mcom(3), magmax, mcomxbb(3) real\*8 mcom1(2), mcom2(2), mcom3(2) cash velocity aberration real\*8 vaber(2), dvaber(2) common / velab / vaber, dvaber cash cash real\*8 fp1i(3),fp2i(3),vaber(3),vaber0(3),vab\_old(2) real\*8 r\_orbit, dvab(3), thabc(3), thabcd(3), sroll, croll, vmag real\*8 phr(3),gyrquan,ordquan,clight,cstar\_n(3,3) PARAMETER (CLIGHT = 2.99792458D8) PARAMETER (R\_ORBIT = 6.378165D6 + 650.D3) COMMON /FP12I/ FP1I, FP2I, VABER equivalence (usdc\_rs(1), vab\_old), (usdc\_rs(3), vaber0(1)), (usdc\_rs(12),phi), (usdc\_rs(17),theta), (usdc\_rs(22),psi), (usdc\_rs(27),x), (usdc\_rs(30),y),(usdc\_rs(33),z), \$ (usdc\_rs(36),th\_delay),(usdc\_rs(52),thsave), (usdc\_rs(68),phr) c Local variable initialization data init / .true. / cjrg Star assumed to be Rigel at Decl = -8.25 deg, RA = 78.025 deg. cjrg Orbit is polar if (init) call initcont (dtcont, mdot, nplot, mplot) cjrg Define bona body from nadir transform bona(1,1) = u(13)bona(2,1) = u(14)bona(3,1) = u(15)bona(1,2) = u(16)bona(2,2) = u(17)bona(3,2) = u(18)bona(1,3) = u(19)bona(2,3) = u(20)bona(3,3) = u(21)

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```
if (.not. vab_on) then
         vaber(1) = 0.d0
         vaber(2) = 0.d0
         vaber(3) = 0.d0
       e1 se
c Calculate guide star velocity abberation in treetops ECI
         cstar_n(3,1) = bona(3,1)
                         bona(3,2)
         cstar_n(3,2) =
         cstar_n(3,3) = bona(3,3)
         vmag = dsqrt(bona(3,1)**2 + bona(3,3)**2)
         cstar_n(1,1) = bona(3,3) / vmag
         cstar_n(1,2) =
                         0.d0
         cstar_n(1,3) = -bona(3,1) / vmag
         cstar_n(2,1) =
              cstar_n(3,2)*cstar_n(1,3) - cstar_n(3,3)*cstar_n(1,2)
     $
         cstar_n(2,2) =
              cstar_n(3,3)*cstar_n(1,1) - cstar_n(3,1)*cstar_n(1,3)
     Ś
         cstar_n(2,3) =
              cstar_n(3,1)*cstar_n(1,2) - cstar_n(3,2)*cstar_n(1,1)
     Ś
         vmag = w_orbit * r_orbit / clight
         vaber(1) = vmag * cstar_n(1,1)
         vaber(2) = vmag \cdot cstar_n(2,1)
         vaber(3) = 0.d0
       endif
C Initial control variables
       if (init) then
         init = .false.
         if (.not. rs_flag) then
           vaber0(1) = vaber(1)
           vaber0(2) = vaber(2)
           vaber0(3) = vaber(3)
           vab_old(1) = vaber(1)
           vab_old(2) = vaber(2)
         endif
       endif
cjrg Compute body gravity gradient torques (spherical and j2). Now only
cirg used in controller to compute GG feedforward terms.
cjrg (Data hard coded for minor axis spinner, 650 Km circular orbit)
       if (GG_ON) call gg_body(time,t_sp_gg,t_j2_gg,f_sp_gg,f_j2_gg,bona)
C For Drag Free Sensor, convert relative spacecraft to (/ SG#1 /) PM
C from inertial to body coordinates and add noise and quantization
       psgli(1) = u(6)
       psg1i(2) = u(7)
       psgli(3) = u(8)
       call intobo (psgli,psglb,1)
       dfs(1) = psg1b(1) + RNORM (seed_dfx, std_dfs, 0.0D0)
                             + RNORM (seed_dfy, std_dfs, 0.0D0)
       dfs(2) = psg1b(2)
                             + RNORM (seed_dfz, std_dfs, 0.0D0)
       dfs(3) = psg1b(3)
       dfs(1) = ORDQUAN(dfs(1), lsb_dfs)
       dfs(2) = ORDQUAN(dfs(2), 1sb_dfs)
       dfs(3) = ORDQUAN(dfs(3), lsb_dfs)
C Apply noise and quantization to the Star Tracker data
       st_roll = u(12) + RNORM (seed_str, std_str, 0.0D0)
       st_roll = ORDQUAN(st_roll,lsb_str)
C Apply noise and quantization to the Science Telescope data
       st_pitch = -u(4) + RNORM (seed_stp, std_sct, 0.0D0)
       st_yaw = u(5) + RNORM (seed_sty, std_sct, 0.0D0)
       st_pitch = ORDQUAN(st_pitch,lsb_sct)
       st_yaw = ORDQUAN(st_yaw,lsb_sct)
C Apply noise and drift to the Control Gyro data
       cg_roll = (u(1) + RNORM (seed_cgr, std_cg, mean_cgr))*dtcont
       cg_pitch = (u(2) + RNORM (seed_cgp, std_cg, mean_cgp))*dtcont
       cg_yaw = (u(3) + RNORM (seed_cgy, std_cg, mean_cgy))*dtcont
C Apply quantization to the Control Gyro data
```

cg\_roll = gyrquan(phr(3),cg\_roll, lsb\_cgr) ! jrg gyro cg\_pitch = gyrquan(phr(2),cg\_pitch,lsb\_cgpy) ! quantization model cg\_yaw = gyrquan(phr(1),cg\_yaw, lsb\_cgpy) ! added 11-25-97  $w_act(1) = cg_yaw/dtcont$ w\_act(2) = cg\_pitch/dtcont  $w_act(3) = cg_roll/dtcont$ c Compute Science Gyro drift angle call sg\_drift (dtcont, da\_ns, da\_ew, time, st\_roll, st\_pitch) C CALCULATE THE DISTURBANCES ON THE SPACECRAFT c Compute magnetic field in the body frame c Transform B to body 1 frame do i = 1,3bb(i) = ctrans(1,i,1)\*bmagi(1) + ctrans(2,i,1)\*bmagi(2) +ctrans(3,i,1)\*bmagi(3) enddo C Compute cryoperm shield feed forward torque if (CRYO\_ON) then  $tcryo_ff(1) = 200.0D4*bb(2)*bb(3)$  $tcryo_{ff(2)} = -200.0D4*bb(1)*bb(3)$  $tcryo_ff(3) = 0.0$ endif C Determine if Rigel is Valid or Invalid call rigel (orbang, RV) cash include velocity aberration into rate loop croll = dcos(st\_roll) sroll = dsin(st\_roll) dvab(1) = vaber(1)-vab\_old(1)  $dvab(2) = vaber(2) - vab_old(2)$ thabcd(2) = (crol1\*dvab(1) + srol1\*dvab(2))/dtcontthabcd(1) = (sroll\*dvab(1) - croll\*dvab(2))/dtcont  $w_{errx}(1) = w_{act}(1) - thabcd(1) ! cjrg$  $w_{errx}(2) = w_{act}(2) - thabcd(2) ! cjrg$ cg\_roll = w\_act(3) \*dtcont cg\_pitch = w\_errx(2)\*dtcont cg\_yaw = w\_errx(1)\*dtcont cash C Compute pitch/yaw attitude from Control Gyro data during Rigel Invalid C Update the attitude quaternion during Rigel Valid if (RV) then cgi\_pitch = st\_pitch cgi\_yaw = st\_yaw call caerr (dtcont, w\_act, a\_act, RV, vaber, vaber0, cstar\_n) else call caerr (dtcont, w\_act, a\_act, RV, vaber, vaber0, cstar\_n) dvab(1) = vaber(1) - vaber(1)dvab(2) = vaber(2) - vaber(2)thabc(2) = croll\*dvab(1) + sroll\*dvab(2)thabc(1) = sroll\*dvab(1) - croll\*dvab(2)  $a_err(1) = a_act(1) - thabc(1) ! cjrg$  $a_{err}(2) = a_{act}(2) - thabc(2) ! cjrg$ cgi\_pitch = a\_err(2) cgi\_yaw = a\_err(1) endif vab\_old(1) = vaber(1)  $vab_old(2) = vaber(2)$ C\*\*\*\*\*\*\*\* ROLL CONTROL \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* c Compute actual roll phase in 0 to 2\*pi (Tpi) range (rad) phi\_c = w\_roll \* time n\_r\_revs = dint(phi\_c/Tpi) phi\_a = st\_roll - n\_r\_revs\*Tpi c Compute commanded roll angle in 0 to 2\*pi range (rads) phi\_c = phi\_c - n\_r\_revs\*Tpi phi(1) = phi\_c - phi\_a phi(2) = w\_roll\*dtcont - cg\_roll

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call pid\_att (phi, tcom(3), uf\_rol, rf\_rol, dtcont, Kroll, limroll, Iroll, w\_roll) C \*\*\*\*\*\* POINTING AND TRANSLATION CONTROLLERS (CALLED AT 10 Hz) \*\*\*\*\*\* C RIGEL VALID CONTROL if (RV) then theta(1) = -st\_pitch  $theta(2) = -cg_pitch$ call pid\_att (theta, tcom(2), uf\_pit, rf\_pit, dtcont, Kpy\_rv, limpy\_rv, Ipy, w\_roll) C\*\*\*\*\*\*\*\*\* YAW CONTROL \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  $psi(1) = -st_yaw$  $psi(2) = -cg_yaw$ call pid\_att (psi, tcom(1), uf\_yaw, rf\_yaw, dtcont, ۶ Kpy\_rv, limpy\_rv, Ipy, w\_roll) endif C RIGEL INVALID CONTROL if (.not.RV) then C\*\*\*\*\*\* PITCH CONTROL \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* theta(1) = -cgi\_pitch  $theta(2) = -cg_pitch$ call pid\_att (theta, tcom(2), uf\_pit, rf\_pit, dtcont, Kpy\_rv, limpy\_rv, Ipy, w\_roll) C\*\*\*\*\*\* YAW CONTROL \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* psi(1) = -cgi\_yaw  $psi(2) = -cg_yaw$ call pid\_att (psi, tcom(1), uf\_yaw, rf\_yaw, dtcont, Kpy\_rv, limpy\_rv, Ipy, w\_roll) endif c Gravity gradient feedforward of sperical earth effects & feedforward of c Cryoperm shield torque disturbance do i=1.3 $tcom_ff(i) = -t_sp_gg(i) + tcryo_ff(i)$ enddo C Compute the attitude torque commands to be generated by magnetic torquers call vcross(bb.tcom ff.bbxtcom) bbmag2 = bb(1)\*bb(1) + bb(2)\*bb(2) + bb(3)\*bb(3) mcom(1) = bbxtcom(1) / bbmag2C mcom(2) = bbxtcom(2) / bbmag2С mcom(3) = bbxtcom(3) / bbmag2C Check for MTB saturation and scale commands if saturation occurs magmax = 0.0C С if (abs(mcom(i)) .gt. magmax) magmax = abs(mcom(i)) c enddo if (magmax .gt. Mmax) then C С do i = 1,3c mcom(i) = mcom(i)\*Mmax/magmax C enddo endif C С mcom1(1) = mcom(1)mcom2(1) = mcom(2)C mcom3(1) = mcom(3)C Apply hysteresis and limit to magnetic torquer bar commands call maghys (mcom1) C call maghys (mcom2)

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call maghys (mcom3) С C Apply scale factor errors (1% uniform distribution) to MTB's r(23) = mcom1(2)\*0.9913061d0r(24) = mcom2(2)\*1.0023300d0С r(25) = mcom3(2)\*0.9996117d0C Compute the attitude torque commands to be generated by thrusters С call vcross(mcom, bb, mcomxbb) С C do i = 1.3 $f(i+3) = tcom_ff(i) - mcomxbb(i) + tcom(i)$ С С do i = 1.3 $f(i+3) = tcom_ff(i) + tcom(i)$ enddo C Convert drag free sensor measurement from body to nadir frame for control call botona (dfs,psgln,time) ! botona uses w\_roll and w\_orbit is approx. psgln(1) = bona(1,1)\*dfs(1) + bona(2,1)\*dfs(2) + bona(3,1)\*dfs(3)psgln(2) = bona(1,2)\*dfs(1) + bona(2,2)\*dfs(2) + bona(3,2)\*dfs(3)psgln(3) = bona(1,3)\*dfs(1) + bona(2,3)\*dfs(2) + bona(3,3)\*dfs(3)! It is used only for control. Is OK! C X Translational Controller x(1) = psgln(1)call pid\_trans(x, uf\_x, rf\_x, dtcont, K\_trans, lim\_trans, m\_trans, w\_roll) C Y Translational Controller y(1) = psgin(2)call pid\_trans(y, uf\_y, rf\_y, dtcont, K\_trans, lim\_trans, m\_trans, w\_roll) C Z Translational Controller z(1) = psgln(3)call pid\_trans(z, uf\_z, rf\_z, dtcont, K\_trans, lim\_trans, m\_trans, w\_roll)  $f_na(1) = rf_x(1)$  $f_na(2) = rf_y(1)$  $f_na(3) = rf_z(1)$ call natobo (f\_na,f\_bo,time)  $f_bo(1) = bona(1,1) * f_na(1) * bona(1,2) * f_na(2) * bona(1,3) * f_na(3) * f_bo(2) = bona(2,1) * f_na(1) * bona(2,2) * f_na(2) * bona(2,3) * f_na(3)$  $f_{bo}(3) = bona(3,1) * f_{na}(1) + bona(3,2) * f_{na}(2) + bona(3,3) * f_{na}(3)$ do i=1,3 $f(i) = f_bo(i)$ if  $(abs(f(i)).gt.lim_trans(2))$   $f(i) = sign(lim_trans(2), f(i))$ C Flow Rate Command f(7) = mdotC Call Jet Thruster Selection Logic - Lockheed (Pseudo Inverse) call THRSEL(time, f, thrust, r\_mflow) C\*\*\*\*\* THRUSTER MODEL \*\*\*\*\* C Quantize the thruster commands do i = 1,16thrust(i) = ORDQUAN(thrust(i), lsb\_thr) C Thruster hysteresis model (includes leakage and limiting) do i = 1,16Thys(1) = th\_delay(i)

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integer njunk

Thys(2) = thsave(i)call thrhys(Thys) r(i) = Thys(2)thsave(i) = Thys(2)enddo C Delay the thruster commands do i = 1,16th\_delay(i) = thrust(i) enddo C Add noise to the thrust and get total thrust thrtot = 0.0do i = 1,16seedthr = seed\_thr(i)  $r(i) = r(i) + RNORM (seedthr, std_thr, 0.0D0)$ seed\_thr(i) = seedthr thrtot = thrtot + r(i)enddo thrctrl = thrtot - r\_mflow C If no closed loop control, then set thrusters to zero if (.not. CLOSED\_LOOP) then do i = 1.16r(i) = 0.000enddo endif RETURN END C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* C GB-B Attitude and Translation Controllers Initialization subroutine initcont (dtcont, mdot, nplot, mplot) implicit none real\*8 dtcont, mdot integer nplot, mplot, i real\*8 Kpy\_rv(5), limpy\_rv(8), Ipy real\*8 Krol1(5), limrol1(8), Irol1 common / attcont / Kpy\_rv, limpy\_rv, Ipy, Kroll, limroll, Iroll real\*8 K\_trans(3), lim\_trans(2), m\_trans common / transcon / K\_trans, lim\_trans, m\_trans real\*8 Th, Tl, Tmax common / thrhys1 / Th, Tl, Tmax real\*8 Mh. Mmax common / maghys1 / Mh, Mmax real\*8 w\_orbit, w\_roll common / rates / w\_orbit, w\_roll logical GG\_ON, CRYO\_ON, VAB\_ON, CLOSED\_LOOP common / env\_flag / GG\_ON, CRYO\_ON, VAB\_ON, CLOSED\_LOOP real\*8 i\_body(3,3) common / ggfeedf / i\_body real\*8 pi, arcrad, radarc C Sensor & actuator disturbance input data C (seeds, standard deviations, least significant bit weights, drifts) integer seed\_str, seed\_stp, seed\_sty integer seed\_cgr, seed\_cgp, seed\_cgy integer seed\_dfx, seed\_dfy, seed\_dfz integer seed\_thr(16)

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real\*8 std\_str, std\_sct, std\_cg, std\_dfs, std\_thr
real\*8 lsb\_str, lsb\_sct, lsb\_cgr, lsb\_cgpy, lsb\_dfs, lsb\_thr real\*8 mean\_cgr, mean\_cgp, mean\_cgy common / disturb1 / seed\_thr, seed\_dfx, seed\_dfy, seed\_dfz, seed\_str, seed\_stp, seed\_sty, seed\_cgr, seed\_cgp, seed\_cgy common / disturb2 / std\_str, std\_sct, std\_cg, std\_dfs, std\_thr, & lsb\_str, lsb\_sct, lsb\_cgr, lsb\_cgpy, lsb\_dfs, lsb\_thr, mean\_cgr, mean\_cgp, mean\_cgy parameter (pi = 3.1415926535897932384d0)parameter (arcrad = pi / (180.0d0\*3600.0d0)) parameter (radarc = 1.0d0 / arcrad) C Initial control variables open (unit=14, file='gains.inp') open (unit=15, file='inputlog.out') write(15,\*) 'Enter controller sampling period (sec)' read(14,\*) dtcont write(15,\*) dtcont write(15,\*) 'Enter no. of dt"s / plot write for data.mat file' read(14,\*) njunk !jrg no longer used write(15,\*) njunk write(15,\*) 'Enter no. of dt"s / plot write for control.mat file' read(14,\*) njunk !jrg no longer used write(15,\*) njunk write(15,\*) 'Enter RV pitch/yaw gains (Kr, Kp, Ki, Kop, Koi)' read(14,\*) Kpy\_rv write(15,\*) Kpy\_rv write(15,\*) 'Enter RV pitch/yaw limits (arcsec)' read(14,\*) limpy\_rv write(15,\*) limpy\_rv do i = 1.8limpy\_rv(i) = limpy\_rv(i) \*arcrad enddo write(15,\*) 'Enter pitch/yaw inertia (kg-m^2)' read(14,\*) Ipy write(15,\*) Ipy write(15,\*) 'Enter roll gains (Kr, Kp, Ki, Kop, Koi)' read(14,\*) Kroll write(15,\*) Kroll write(15,\*) 'Enter roll limits (arcsec)' read(14,\*) limroll write(15,\*) limroll do i = 1.8limroll(i) = limroll(i)\*arcrad enddo write(15,\*) 'Enter roll inertia (kg-m^2)' read(14,\*) Iroll write(15,\*) Iroll write(15,\*) 'Enter translational gains (Kr, Kp, Ki)' read(14,\*) K\_trans write(15,\*) K\_trans write(15,\*) 'Enter translational limits (m, N)' read(14,\*) lim\_trans write(15,\*) lim\_trans write(15,\*) 'Enter mass for translational control (kg)' read(14,\*) m\_trans write(15,\*) m\_trans

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write(15,\*) 'Enter Thruster leakage, hysteresis & maximum (N)' read(14,\*) Tl, Th, Tmax write(15,\*) Tl, Th, Tmax write(15,\*) 'Enter Magnetic Torquer hysteresis & maximum (ATM^2)' read(14,\*) Mh, Mmax write(15,\*) Mh, Mmax write(15,\*) 'Enter mass flow rate command (kg/sec)' read(14.\*) mdot write(15,\*) mdot write(15,\*) 'Enter spacecraft inertia matrix' read(14,\*) (i\_body(1,i),i=1,3) read(14,\*) (i\_body(2,i),i=1,3) read(14,\*) (i\_body(3,i),i=1,3) write(15,\*) (i\_body(1,i),i=1,3) write(15,\*) (i\_body(2,i),i=1,3) write(15,\*) (i\_body(3,i),i=1,3) write(15,\*) 'Enter Earth orbit rate (rad/sec)' read(14,\*) w\_orbit write(15,\*) w\_orbit write(15,\*) 'Enter GPB commanded roll rate (deg/sec)' read(14,\*) w\_roll
write(15,\*) w\_roll  $w_roll = w_roll*pi/180.0d0$ write(15,\*) 'Gravity Gradient Force/Torque On (check .INT also)' read(14,\*) GG\_ON write(15,\*) GG\_ON write(15,\*) 'Cryoperm Shield Magnetic Torque On' read(14,\*) CRYO ON write(15,\*) CRYO\_ON write(15,\*) 'Velocity aberration feedforward On (check .INT also)' read(14,\*) VAB\_ON write(15,\*) VAB\_ON write(15,\*) 'Controller in Closed Loop Mode (thrusters enabled)' read(14,\*) CLOSED\_LOOP write(15,\*) CLOSED\_LOOP close (14) open (unit=14, file='errors.inp') write(15,\*) 'Enter roll Star Tracker noise seed' read(14,\*) seed\_str write(15,\*) seed\_str write(15,\*) 'Enter pitch & yaw Science Telescope noise seeds' read(14,\*) seed\_stp, seed\_sty write(15,\*) seed\_stp, seed\_sty write(15,\*) 'Enter Control Gyro (roll, pitch, yaw) noise seeds' read(14,\*) seed\_cgr, seed\_cgp, seed\_cgy write(15,\*) seed\_cgr, seed\_cgp, seed\_cgy write(15,\*) 'Enter Drag Free Sensor (x, y, z) noise seeds' read(14,\*) seed\_dfx, seed\_dfy, seed\_dfz write(15,\*) seed\_dfx, seed\_dfy, seed\_dfz write(15,\*) 'Enter 16 Thruster noise seeds' read(14,\*) seed\_thr write(15,\*) seed\_thr write(15,\*) 'Enter roll Star Tracker noise standard deviation' write(15,\*) \*(in Arcseconds)' read(14,\*) std str write(15,\*) std\_str

std\_str = std\_str\*arcrad

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write(15,\*) 'Enter ST noise standard deviation' write(15,\*) '(in milliArcseconds)' read(14,\*) std\_sct write(15,\*) std\_sct std\_sct = std\_sct\*arcrad\*1.0D-3 write(15,\*) 'Enter Control Gyro noise standard deviation' write(15,\*) '(in Arcseconds/sec)' read(14,\*) std\_cg write(15,\*) std\_cg std\_cg = std\_cg\*arcrad write(15,\*) 'Enter Drag Free Sensor noise standard deviation' write(15,\*) '(in nanometers)' read(14,\*) std\_dfs write(15,\*) std\_dfs std\_dfs = std\_dfs\*1.0D-9 write(15,\*) 'Enter Thruster noise standard deviation' write(15,\*) '(in milliNewtons)' read(14,\*) std\_thr write(15,\*) std\_thr std\_thr = std\_thr\*1.0D-3 write(15,\*) 'Enter roll Star Tracker least significant bit' write(15,\*) '(in Arcseconds)' read(14,\*) lsb\_str write(15,\*) lsb\_str lsb\_str = lsb\_str\*arcrad write(15,\*) 'Enter ST least significant bit' write(15,\*) '(in milliArcseconds)' read(14,\*) lsb\_sct write(15,\*) lsb\_sct lsb\_sct = lsb\_sct\*arcrad\*1.0D-3 write(15,\*) 'Enter Roll Control Gyro least significant bit' write(15,\*) '(in milliArcseconds)' read(14,\*) lsb\_cgr write(15,\*) lsb\_cgr lsb\_cgr = lsb\_cgr\*arcrad\*1.0D-3 write(15,\*) 'Enter Pitch/Yaw Control Gyro least significant bit' write(15,\*) '(in milliArcseconds)' read(14,\*) lsb\_cgpy write(15,\*) lsb\_cgpy lsb\_cgpy = lsb\_cgpy\*arcrad\*1.0D-3 write(15,\*) 'Enter Drag Free Sensor least significant bit' write(15,\*) '(in nanometers)' read(14, •) lsb\_dfs write(15,\*) lsb\_dfs lsb\_dfs = lsb\_dfs\*1.0D-9 write(15,\*) 'Enter Thruster least significant bit' write(15,\*) '(in milliNewtons)' read(14,\*) 1sb\_thr write(15,\*) lsb\_thr lsb\_thr = lsb\_thr\*1.0D-3 write(15,\*) 'Enter Control Gyro drift (roll, pitch, yaw)' write(15,\*) '(in Arcseconds/sec)' read(14,\*) mean\_cgr, mean\_cgp, mean\_cgy write(15,\*) mean\_cgr, mean\_cgp, mean\_cgy mean\_cgr = mean\_cgr\*arcrad mean\_cgp = mean\_cgp\*arcrad mean\_cgy = mean\_cgy\*arcrad close(14) close(15) return end C Discrete Proportional, Integral, Derivative Controller

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C for ATTITUDE control C C Inputs: u(1) attitude error input (rad)

```
u(2) delta attitude error input (rad)
C
          u(3) second previous controller input
                Kr
                       rate gain
C
          K(1)
                       position gain
С
          K(2)
                 Κp
С
          K(3)
                Κi
                      integral gain
         ጥ
               sample period
             Tcom
                    commanded torque
  Outputs:
                    present filtered angular acceleration command
             rf(1)
             rf(2) previous filtered angular acceleration command
                    second previous filtered angular acceleration command
             rf(3)
C
C*********
       subroutine pid_att (u, Tcom, uf, rf, T, K, lim, Inertia, w_roll)
       implicit none
       real*8 u(5), Tcom, uf(3), rf(3), T, K(5), lim(8), Inertia, w_roll
       real*8 yrate, ypos, yint
       real*8 yop
       real*8 wa, wb, za, zb, c_rrf(6)
C Limit attitude error
       if (abs(u(1)).gt.lim(1)) u(1) = sign(lim(1),u(1))
C Observer
       yop = K(4) *T*(u(1)-u(4))
CO
CO
       u(5) = K(5) *T*T*(u(1)-u(4)) + u(5)
       if (abs(u(5)).gt.lim(2)) u(5) = sign(lim(2),u(5))
CO
       u(4) = yop + u(5) + u(4) + u(2)
       if (abs(u(4)).gt.lim(3)) u(4) = sign(lim(3),u(4))
CO
C Rate loop
       yrate = (u(2)+u(5))*K(1)/T
       yrate = u(2)*K(1)/T
       if (abs(yrate).gt.lim(6)) yrate = sign(lim(6), yrate)
C Proportional Loop
       ypos = u(4)
       ypos = u(1)
       if (abs(ypos).gt.lim(4)) ypos = sign(lim(4),ypos)
C Integral loop
       yint = K(3)*T*u(4) + u(3)
       yint = K(3)*T*u(1) + u(3)
       if (abs(yint).gt.lim(5)) yint = sign(lim(5),yint)
       u(3) = yint
C Sum PID loops to compute input to the roll rate filter
       uf(1) = yint + ypos + yrate
C Compute the coefficients of the roll rate filter
       if (wa .ne. dabs(w_roll)) then
print *, 'control gains ',k
         wa = dabs(w_roll)
         wb = wa
         za = 3.0d0
         zb = 0.003d0
         c_{rrf(1)} = (4.0d0 + 4.0d0*T*za*wa + wa**2*T**2) * wb**2 /wa**2
         c_{rrf(2)} = (2.0d0*wa**2*T**2 - 8.0d0) * wb**2 / wa**2
         c_{rrf(3)} = (wa**2*T**2 - 4.0d0*T*za*wa + 4.0d0) * wb**2 / wa**2
         c_{rrf}(4) = 4.0d0 + 4.0d0*T*zb*wb + wb**2*T**2
         c_{rrf}(5) = (2.0d0*wb**2*T**2 - 8.0d0)
         c_rrf(6) = (wb**2*T**2 - 4.0d0*T*zb*wb + 4.0d0)
       endif
       call discfil2 (uf,rf,c_rrf)
       if (abs(rf(1)).gt.lim(7)) rf(1) = sign(lim(7),rf(1))
       Tcom = K(2) *rf(1) *Inertia
       return
       end
```

C Discrete Proportional, Integral, Derivative Controller

```
C for TRANSLATION control in Nadir frame
C Inputs: u(1) controller input
C
          u(2) previous rate loop input
          u(3) previous integral loop input
C
                Kr rate gain
С
          K(1)
C
          K(2)
                Кp
                       position gain
               Ki
                      integral gain
C
          K(3)
               sample period
C Outputs: rf(1) filtered force command output
       subroutine pid_trans (u, uf, rf, T, K, lim, mass, w_roll)
       implicit none
       real*8 u(3), uf(3), rf(3), T, K(3), lim(2), mass, w_roll
       real*8 yrate, ypos, yint
       real*8 wa, wb, za, zb, c_rrf(6)
C Rate loop
       yrate = u(1)*K(1)/T - u(2)
       u(2) = u(1) *K(1)/T
C Proportional Loop
       ypos = u(1)
C Integral loop
       yint = K(3)*T*u(1) + u(3)
       if (abs(yint).gt.lim(1)) yint = sign(lim(1),yint)
       u(3) = yint
C Sum PID loops to compute input to the roll rate filter
       uf(1) = (yint + ypos + yrate) *K(2) *mass
C Compute the coefficients of the roll rate filter
       if (wa .ne. dabs(w_roll)) then
       wa = dabs(w_roll)
       wb = wa
       za = 3.0d0
       zb = 0.003d0
       c_{rrf}(1) = (4.0d0 + 4.0d0*T*za*wa + wa**2*T**2) * wb**2 /wa**2
       c_{rrf(2)} = (2.0d0*wa**2*T**2 - 8.0d0) * wb**2 / wa**2
       c_{rrf}(3) = (wa**2*T**2 - 4.0d0*T*za*wa + 4.0d0) * wb**2 / wa**2
       c_rf(4) = 4.0d0 + 4.0d0*T*zb*wb + wb**2*T**2
       c.rrf(5) = (2.0d0*wb**2*T**2 - 8.0d0)
       c_{rrf(6)} = (wb**2*T**2 - 4.0d0*T*zb*wb + 4.0d0)
       endif
       call discfil2 (uf,rf,c_rrf)
       return
       end
C Subroutine to convert from spacecraft inertial to spacecraft
C body "NDZ" frame. This transformation uses treetops body to inertial
C transformation and is therefore exact. It should be used only to compute
C disturbances or outputs.
       subroutine intobo (pi,pb,ndz)
       implicit none ! double precision (a-h,o-z)
       real*8 pi(3), pb(3)
       integer i,ndz
       include 'DBP.F'
       include 'DBB.F'
       do i = 1.3
      pb(i) = ctrans(1,i,ndz)*pi(1) + ctrans(2,i,ndz)*pi(2) +
             ctrans(3,i,ndz)*pi(3)
       enddo
       return
               ***************
```

C Subroutine to convert from spacecraft body "NDZ" to spacecraft inertial frame. This transformation uses treetops body to inertial transformation and is therefore exact. Should not be used for control, C but only to compute spacecraft disturbances. subroutine botoin (pb,pi,ndz) implicit none ! double precision (a-h,o-z) real\*8 pi(3), pb(3) integer i,ndz include 'DBP.F' include 'DBB.F' do i = 1,3pi(i) = ctrans(i,1,ndz)\*pb(1) + ctrans(i,2,ndz)\*pb(2) +ctrans(i,3,ndz)\*pb(3) enddo return end C Subroutine to apply hysteresis to the thruster command C T(1) = Thruster Command Input C T(2) = Thruster Command Output subroutine thrhys (T) implicit none ! double precision (a-h,o-z) real\*8 T(2) real\*8 Th, Tl, Tmax common / thrhys1 / Th, Tl, Tmax CC NO HYSTERESIS if (Th .eq. 0.0d0) then t(2) = t(1)if (T(2) .gt. Tmax) T(2) = Tmaxreturn endif if (T(1).gt.T(2)-T1 .and. T(1).lt.T(2)+Th-T1) then С C T(2) = T(2)elseif (T(1).ge.T(2)+Th-T1) then C С T(2) = T(1) - Th + Tlelseif (T(1).le.T(2)-T1) then С С T(2) = T(1) + T1С endif if (T(2) .1t. T1) T(2) = T1if (T(1).lt.Tl-Th) T(1) = Tl-Thif (T(1).gt.T(2)-Th .and. T(1).lt.T(2)+Th) then T(2) = T(2)elseif (T(1).ge.T(2)+Th) then T(2) = T(1) - Thelseif (T(1).le.T(2)-Th) then T(2) = T(1) + Thendif if (T(2) .gt. Tmax) T(2) = Tmaxreturn end C Subroutine to apply Hysteresis to the Magnetic Torquer Command C M(1) = Magnetic Torquer Command Input C M(2) = Magnetic Torquer Command Output subroutine maghys (M)

implicit none ! double precision (a-h,o-z)

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```
real*8 M(2)
      real*8 Mh, Mmax
      common / maghys1 / Mh, Mmax
      if (M(1).gt.M(2)-Mh .and. M(1).lt.M(2)+Mh) then
       M(2) = M(2)
      elseif (M(1).ge.M(2)+Mh) then
       M(2) = M(1) - Mh
      elseif (M(1).le.M(2)-Mh) then
       M(2) = M(1) + Mh
      if (abs(M(2)) .gt. Mmax) M(2) = sign(Mmax,M(2))
      return
      end
subroutine vcross(u, v, w)
cc Function: Computes the cross product of two vectors.
CC
cc Source: JC
CC
cc Explicit Inputs:
CC
           u(3) - first vector
           v(3) - second vector
CC
CC
cc Explicit Output:
CC
           w(3) = u \times v
CC
cc Comments: Real*8
CC
implicit none ! double precision (a-h,o-z)
     real*8 u(3), v(3), w(3)
     w(1)=u(2) * v(3) - u(3) * v(2)
     w(2)=u(3) * v(1) - u(1) * v(3)
     w(3)=u(1) * v(2) - u(2) * v(1)
     end
subroutine trace(a, tr, n)
cc Function: Computes the trace of an nxm (square) matrix.
CC
cc Source: JC
CC
cc Explicit Inputs:
          a - arbitrary nxn matrix
CC
          n - dimension of square "a" matrix
CC
CC
cc Explicit Outputs:
          tr - trace; sum of diagonal elements.
CC
CC
cc Comments: Real*8
CC
C
C
     implicit none ! double precision (a-h,o-z)
С
     integer i, n
¢
     real*8 a(n,n), tr
C
     tr = 0.e0
C
C
    do 20 i=1,n
```

tr = tr + a(i,i)

С

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```
c 20
      continue
C
С
      return
С
      end
С
subroutine d_rot(iaxis, ang, dcm)
cc Function: Generate 3x3 rotation matrix based on inputs.
CC
                        Date: 12/90
cc Source: JC
CC
cc Comments: Real*8
                           Rotated to inertial trans
CC
             iaxis(+)
                      -->
                           Inertial to rotated trans
CC
             iaxis(-)
CC
C
C
      implicit none ! double precision (a-h,o-z)
      integer iaxis
C
      real*8 dcm(3,3), ang
C
      real*8 axis,ca,sa
C
С
      axis = dble(iaxis)
      ca = dcos(ang)
C
C
      sa = dsin(ang)
cc Build selected rotation matrix
      goto(10,20,30), iabs(iaxis)
C
ccc Rotation about axis 1 (x)
   10 \text{ dcm}(1,1) = 1.0e0
C
      dcm(2,2) = ca
      dcm(3,3) = ca
C
      dcm(3,2) = sa*sign(1.0,axis)
С
      dcm(2,3) = -dcm(3,2)
С
      dcm(1,2) = 0.0e0
C
      dcm(1,3) = 0.0e0
      dcm(2,1) = 0.0e0
C
      dcm(3,1) = 0.0e0
С
C
      return
С
ccc Rotation about axis 2 (y)
С
   20 \text{ dcm}(1,1) = ca
      dcm(3,3) = ca
      dcm(1,3) = sa*sign(1.0,axis)
С
      dcm(3,1) = -dcm(1,3)
      dcm(2,2) = 1.0e0
С
      dcm(2,1) = 0.0e0
     dcm(1,2) = 0.0e0
C
     dcm(2,3) = 0.0e0
С
     dcm(3,2) = 0.0e0
C
С
     return
С
ccc Rotation about axis 3 (z)
   30 \text{ dcm}(1,1) = ca
C
     dcm(2,2) = ca
c
     dcm(2,1) = sa*sign(1.0,axis)
     dcm(1,2) = -dcm(2,1)
С
C
     dcm(3,3) = 1.0e0
     dcm(1,3) = 0.0e0
С
     dcm(2,3) = 0.0e0
C
     dcm(3,1) = 0.0e0
C
     dcm(3,2) = 0.0e0
C
     return
С
C
      end
C
```

subroutine dyad\_xd(a, dyad, b, c)

cc Explicit Output:

CC cc Function: Compute  $c = a \times dyad$ . b CC where a, b, c are vectors dyad is a "3x3 dyadic" CC CC Source: JC Date: 12/19/90 CC CC cc Comments: Real\*8 Uses other dutil subroutines/functions. CC CC implicit none ! double precision (a-h,o-z) integer i, i real\*8 dyad(3,3), a(3), b(3), c(3) real\*8 temp(3), ddb(3), d\_dot cc Compute (dyad . b = ddb) do 20 i=1,3do 10 j=1,3temp(j) = dyad(i,j)10 continue  $ddb(i) = d_dot(temp, b)$ 20 continue cc Compute (a x ddb = c) call vcross(a, ddb, c) return end function d\_dot(u, v) cc Function: Compute the dot product of two vectors  $(d_{dot} = u \cdot v)$ . CC cc Source: JC CC cc Explicit Inputs: CC u(3) - first vector v(3) - second vector CC CC cc Comments: Real\*8 version CC implicit none ! double precision (a-h,o-z) real\*8 d\_dot, u(3), v(3)  $d_{dot} = u(1) \cdot v(1) + u(2) \cdot v(2) + u(3) \cdot v(3)$ return end subroutine d\_mxv(m, v, u) CC cc Function: To compute product of a matrix(3x3) and a vector(3x1). CC Source: JC CC CC cc Explicit Inputs: CC m(3,3) - arbitrary 3x3 matrix CC v(3,1) - arbitrary vector CC

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```
CC
          u(3,1) - result of matrix times vector
CC
CC
   Comments: Real*8
CC
implicit none ! double precision (a-h,o-z)
     real*8 m(3,3), u(3), v(3)
     u(1) = m(1,1) * v(1) + m(1,2) * v(2) + m(1,3) * v(3)
     u(2) = m(2,1) * v(1) + m(2,2) * v(2) + m(2,3) * v(3)
     u(3) = m(3,1) * v(1) + m(3,2) * v(2) + m(3,3) * v(3)
     return
     end
subroutine d_mtrans(A, AT, m, n)
CC
CC
  Function: Transpose mxm matrix.
CC
cc Source: JC
CC
cc Explicit Input:
CC
          A(m,n) - arbitrary mxn matrix
CC
cc Explicit Output:
          AT(n,m) - transpose of matrix A
CC
CC
  Comments: Real*8
CC
CC
implicit none
     integer i, j, m, n
     REAL*8 A(m,n), AT(n,m)
      do 20 i=1, m
        do 10 j=1,n
            AT(j,i) = A(i,j)
     continue
 10
 20 continue
      return
      end
subroutine d_mmul(A,B,C,L,M,N)
cc Function: Multiply two matrices of arbitrary "outside"
CC
          dimensions
CC
cc Source: JG via JC
cc Inputs: A(L x M) - first matrix
CC
         B(M x N) - second matrix
         L - row dimension of first matrix
CC
        M - column dimension of first matrix and row dimension
CC
           of second matrix
CC
        N - column dimension of second matrix
CC
CC
cc Outputs: C(L x N) - resultant matrix from A*B
CC
CC
  Comments: Real*8
CC
          Vector arrays are (3x1) matrices
CC
```

implicit none ! double precision (a-h,o-z)

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else

endif

RV = .false.

Contract No.: NAS8-00114 INTEGER L,M,N,I,J,K REAL\*8 A(L,M), B(M,N), C(L,N), TDO I=1,L DO J=1, N T=0.0 DO K=1, M T=T+A(I,K)\*B(K,J)ENDDO C(I,J)=TENDDO ENDDO RETURN subroutine discfil2 (x,y,c) \*\*\*\*\* С С Function: Second Order Discrete Filter С C c1\*z\*\*2 + c2\*z + c3С c4\*z\*\*2 + c5\*z + c6 C C Inputs: C x(1)present input x(2)previous input C x(3)second previous input c(1:6) coefficients of filter C Outputs: y(1) present output С previous output y(2) C y(3) second previous output C Comments: Real\*8 implicit none ! double precision (a-h,o-z) real\*8 x(3), y(3), c(6) y(1) = (c(1)\*x(1) + c(2)\*x(2) + c(3)\*x(3) c(5)\*y(2) - c(6)\*y(3) ) / c(4)x(3) = x(2) $\mathbf{x}(2) = \mathbf{x}(1)$ y(3) = y(2)y(2) = y(1)return end C Subroutine to determine whether GPB is in the Rigel Valid (RV) or C Rigel Invalid (RI) control mode and to determine when GPB is in the C RI to RV or RV to RI transition phases. subroutine rigel (orbang, RV) implicit none ! double precision (a-h,o-z) real\*8 lat, orbang, raddeg logical RV data raddeg / 57.2957795d0 / lat = atan2(sin(orbang),cos(orbang))\*raddeg lat = dmod(raddeg \* orbang, 360.d0); if (lat .gt.180.d0) lat = lat - 360.d0 C if (lat .gt. -98.24 .and. lat .le. 81.76) then if (lat .gt. -115.24 .and. lat .le. 98.76) then RV = .true.

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C

 $l_flow = (16.0*T1) / (ISP*9.81)$ 

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return end SUBROUTINE THRSEL(time, f, r, r\_mflow) cc Function: Lockheed Pseudo Inverse Thruster Selection Logic CC for GPB 16 thruster configuration CC Commanded Forces (x, y, z) from trans controller CC Inputs: F(1-3) Commanded Torques (roll, pitch, yaw) from attitude CC F(4-6) controller after magnetic torque is subtracted. CC CC F(7) Commanded Mass Flow CC cc Outputs: R(1-16) Thruster commands implicit none integer i, j, i2 real\*8 time, f(7), r(16), r\_mflow real\*8 A(6,8), AINV(8,6), AT(8,6), AAT(6,6), AATINV(6,6) real\*8 ISP, fortorq(6), fpair(8), sumjets(6) real\*8 flow, 1\_flow, flowc logical first\_pass real\*8 Th, Tl, Tmax common / thrhys1 / Th, Tl, Tmax DATA ISP / 130.0d0 / data first\_pass / .true. / c Read in thruster pair force/torque matrix if (first\_pass) then first\_pass = .false. open(unit=13, file='thruster.inp', status='old') do i = 1.6read(13,\*) (A(i,j),j=1,8)enddo close(13) endif C Compute the pseudo inverse of the thruster pair force/torque matrix call d\_mtrans (A, AT, 6, 8) call d\_mmul (A, AT, AAT, 6, 8, 6) call minv6x6 (AAT, AATINV) call d\_mmul (AT, AATINV, AINV, 8, 6, 6) C Compute the thruster pair forces do i = 1,6fortorq(i) = f(i)sumjets(i) = 0.d0call d\_mmul (AINV, fortorg, fpair, 8, 6, 1) C Compute the force to each thruster do i = 1.8j = (i-1)\*2 + 1if (fpair(i) .gt. 0.0d0) then r(j) = fpair(i)r(j+1) = 0.0d0else r(i) = 0.0d0r(j+1) = dabs(fpair(i))endif enddo C Compute flow command less leakage flow = 0.0

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 $flowc = f(7) - l_flow$ flowc = f(7)c Sum mass flow due to current thrust commands do i=1,16flow = flow + r(i) / (ISP \* 9.81)enddo c Compute total thrust error due to total mass flow error if (flow .gt. flowc ) then С write(6,\*) '\*\*\* Mass Flow from Thrusters > Com Mass Flow \*\*\*' C write(6,\*) 'time = ',time, ' thruster mass flow (kg/s) = ',flow C endif c Compute and distribute residual thrust requirements evenly over body (i.e., no resultant force/torque) r\_mflow = (flowc - flow) \* ISP \* 9.81 if  $(r_mflow .1t. 0.0d0) r_mflow = 0.0d0$ do i=1,16 $r(i) = r(i) + r_mflow / 16.0d0$ enddo do i=1,8i2 = 2\*ido j=1,6sumjets(j) = sumjets(j) + a(j,i)\*(r(i2-1)-r(i2))enddo enddo c Add leakage back in to each thruster do i = 1,16C r(i) = r(i) + T1C enddo C RETURN END C 6X6 MATRIX INVERSE SUBROUTINE MINV6X6(A, AI) IMPLICIT NONE INTEGER i,j REAL\*8 A(6,6), AI(6,6) REAL\*8 B(3,3), C(3,3), D(3,3), E(3,3), BI(3,3), EI(3,3) REAL\*8 X(3,3), Y(3,3), Z(3,3), U(3,3) REAL\*8 CEI(3,3), CEID(3,3), DBI(3,3), DBIC(3,3), XI(3,3), UI(3,3) REAL\*8 BIC(3,3), EID(3,3) DO i=1.3DO j=1,3B(i,j) = A(i,j)ENDDO DO i=1.3C(i,j) = A(i,j+3)**ENDDO** ENDDO DO i=1,3DO j=1,3D(i,j) = A(i+3,j)DO j=1,3 E(i,j) = A(i+3,j+3)ENDDO **ENDDO** CALL MINV3x3(B,BI) CALL MINV3x3(E,EI) CALL d\_mmul (C,EI,CEI,3,3,3) CALL d\_mmul (CEI,D,CEID,3,3,3) CALL d\_mmul (D,BI,DBI,3,3,3) CALL d\_mmul (DBI,C,DBIC,3,3,3) DO i=1,3

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```
DO j=1,3
           XI(i,j) = B(i,j) - CEID(i,j)
         ENDDO
       ENDDO
       DO i=1,3
         DO j=1,3
          UI(i,j) = E(i,j) - DBIC(i,j)
         ENDDO
       ENDDO
       CALL MINV3x3(XI,X)
       CALL MINV3x3 (UI,U)
       CALL d_mmul (BI,C,BIC,3,3,3)
       CALL d_mmul (BIC,U,Y,3,3,3)
       CALL d_mmul (EI,D,EID,3,3,3)
       CALL d mmul (EID, X, Z, 3, 3, 3)
       DO i=1,3
         DO j=1,3
           AI(i,j) = X(i,j)
         ENDDO
         DO j=1,3
          AI(i,j+3) = -Y(i,j)
         ENDDO
       ENDDO
       DO i=1,3
         DO j=1,3
           AI(i+3,j) = -Z(i,j)
         ENDDO
         DO j=1,3
          AI(i+3,j+3) = U(i,j)
         ENDDO
       ENDDO
       RETURN
       END
C 3X3 MATRIX INVERSE
       SUBROUTINE MINV3X3(A,AI)
       IMPLICIT NONE
       REAL*8 A(3,3),AI(3,3),DET
       DET = A(1,1)*A(2,2)*A(3,3) + A(1,2)*A(2,3)*A(3,1) +
           A(1,3)*A(2,1)*A(3,2) - A(3,1)*A(2,2)*A(1,3) -
           A(3,2)*A(2,3)*A(1,1) - A(3,3)*A(2,1)*A(1,2)
       if (det .eq. 0.0d0) then
         write(6,*)'DETERMINANT = 0 in 3x3 MATRIX INVERSE'
       endif
       AI(1,1) = (A(2,2)*A(3,3) - A(3,2)*A(2,3))/DET
       AI(2,1) = -(A(2,1)*A(3,3) - A(3,1)*A(2,3))/DET
       AI(3,1) = (A(2,1)*A(3,2) - A(3,1)*A(2,2))/DET
       AI(1,2) = -(A(1,2)*A(3,3) - A(3,2)*A(1,3))/DET

AI(2,2) = (A(1,1)*A(3,3) - A(3,1)*A(1,3))/DET
      AI(3,2) = -(A(1,1)*A(3,2) - A(3,1)*A(1,2))/DET

AI(1,3) = (A(1,2)*A(2,3) - A(2,2)*A(1,3))/DET
       AI(2,3) = -(A(1,1)*A(2,3) - A(2,1)*A(1,3))/DET
       AI(3,3) = (A(1,1)*A(2,2) - A(2,1)*A(1,2))/DET
       RETURN
       END
SUBROUTINE CAERR (DT, W_ERR, A_ERR, RV, VAB, VABO, CSTAR_N)
CC FUNCTION: Compute pitch and yaw attitude angles,
   jrg revision, 11-22-97 and later
IMPLICIT NONE
       include 'rstrt.f'
CC Local declarations
       REAL*8 DT,W_ERR(3),WI_ERR(3),A_ERR(3),CSTAR_N(3,3)
       REAL*8 VAB(3), VABO(3), DVABB(2), WSI(2)
       INTEGER I
```

63

CC

CC CC CC

CC CC CC

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CC

LOGICAL RV, RVP, VASET

```
real*8 w_orbit,w_roll
       common / rates / w_orbit, w_roll
       equivalence (usdc_rs(6),wi_err(1))
       data rvp, vaset /.false., .false./
       IF (RV) THEN
        IF (.NOT. RVP) THEN
          print *, ' Start guide star valid'
          RVP = .TRUE.
        ENDIF
        IF (CSTAR_N(3,3) .GE. 0.D0 .AND. CSTAR_N(3,1) .LT. -0.9D0) THEN
          IF (.NOT. VASET) THEN
            WI\_ERR(1) = 0.D0
            WI\_ERR(2) = 0.D0
            VABO(1) = VAB(1)
            VABO(2) = VAB(2)
            VABO(3) = VAB(3)
            VASET = .TRUE.
          ENDIF
        ENDIF
       ELSEIF (RVP) THEN
print *, ' Start guide star invalid'
        RVP = .FALSE.
        VASET = .FALSE.
       ENDIF
       A_{ERR}(1) = WI_{ERR}(1)
       A_ERR(2) = WI_ERR(2)
      wsi(1) = w_err(1) + w_err(3) *a_err(2)
      wsi(2) = w_err(2) - w_err(3) *a_err(1)
      WI\_ERR(1) = WI\_ERR(1) + WSI(1)*DT
      WI\_ERR(2) = WI\_ERR(2) + WSI(2)*DT
      A_ERR(1) = wi_err(1)
      A_ERR(2) = wi_err(2)
      RETURN
      END
REAL*8 FUNCTION UFMAG(A)
CC
   FUNCTION:
              Compute the magnitude of a vector.
                |A| = 1/A(1) + A(2) + A(3)
   ARGUMENT LIST INPUTS:
              A(3) - Vector
   SUBROUTINES AND FUNCTIONS CALLED:
   COMMENTS:
             Real*8
IMPLICIT NONE
      REAL*8 A(3)
      UFMAG = DSQRT( A(1)*A(1) + A(2)*A(2) + A(3)*A(3))
      RETURN
      END
   John Glaese gyro quantization model, 11-25-97
     Models operation of pulse rebalanced, strapdown rate gyros
      real*8 function gyrquan(phrp,wdt,1)
      implicit none
```

3

0.0D0, 0.0D0, 0.0075147D0,

real\*8 phr,phrp,wdt,1 phr = phrp + wdtif (1 .ne. 0.d0) then gyrquan = dint(phr / 1) • 1 else gyrquan = phr endif phrp = phr - gyrquan return C Ordinary quantization routine with protection for quantization at 0. real\*8 function ordquan(phr,1) implicit none real\*8 phr.1 if (1 .ne. 0.d0) then ordquan = dint(phr / 1) \* 1 else ordquan = phr endif return end C Subroutine to compute the Science Gyro drift angle subroutine sg\_drift (dtcont, da\_ns, da\_ew, time, st\_roll,st\_pitch) implicit none ! double precision (a-h,o-z) include 'DBP.F' include 'DBSP.F' include 'DBB.F' include 'DBS.F' include 'rstrt.f' c Variables for suspension force vector on GP-B Science Gyro from SPRING.FOR real\*8 F\_sgi(3), ufmag common / sg / F\_sgi real\*8 Fsg\_rotor(3,4),T\_per(3),H(3,4),Hmag,H0,uh(3,4) real\*8 xcm2cg(3), d, Fsg\_rotorb(3),factb(3,4) !,tfacti(3,4) real\*8 dtcont, da\_ns(4), da\_ew(4), st\_roll,st\_pitch real\*8 Fsg\_rotorp(3),ufix(3),ufiy(3),ufiz(3),rfix(3),rfiy(3) real\*8 rfiz(3),c\_gss(6) real\*8 deltar, elect\_half, preload\_acc, t1i(3), t2i(3) integer i, kount, jgyro, kkf c Science gyro GG force calculation variables real\*8 fsg\_gg(3,4), fsg\_ggi(3,4), fsg\_j2\_gg(3,4), fsg\_j2\_ggi(3,4) real\*8 tsg\_j2\_gg(3,4), tsg\_j2\_ggi(3,4), tsg\_gg(3,4), tsg\_ggi(3,4) real\*8 sg\_1,sg\_2,sg\_3,sg\_4,sg\_1c,sg\_2c,sg\_3c,sg\_4c real\*8 squid\_x, squid\_y, tele\_x, tele\_y, thet1, thet2, thet3 real\*8 Hbody(3), tele\_body(3), VABER(3), vab\_x, vab\_y common / sg\_gg / fsg\_gg, tsg\_j2\_gg, fsg\_j2\_gg, tsg\_gg real\*8 time,serr\_p(2),serr\_y(2),pi\_loc,arcrad,radarc,dtkfil logical firstpass, ier parameter (pi\_loc = 3.1415926535897932384d0)
parameter (arcrad = pi\_loc / (180.0d0\*3600.0d0)) parameter (radarc = 1.0d0 / arcrad) real\*8 fp1i(3),fp2i(3), st\_vec(3), ust\_vec(3),perr COMMON /FP12I/ FP1I, FP2I, VABER equivalence (usdc\_rs(71),h) data dtkfil, firstpass /8.6d0, .true. / H=Iw where Inertia=9.2E-6 kg-m<sup>2</sup> and w = 2\*pi\*(130 Hz)data H0 / 0.0075147D0 / C data H / 0.0D0, 0.0D0, 0.0075147D0, C 1 C 2 0.0D0, 0.0D0, 0.0075147D0,

Date: 14 February 2003

```
0.0D0, 0.0D0, 0.0075147D0 /
       data d / -5.08D-8/
       data deltar / -5.08D-8/
       data elect_half / 0.5061454830784d0 /
data preload_acc / 1.962d-6 /
       data c_gss / 0.D0,
                     2.714382128894188D-3,
                     2.620082137667179D-3,
     3
                     1.D0.
                    -1.894031723107232D0,
     4
                     8.993661873737933D-1 /
     5
  firstpass stuff
       if (firstpass) then
          firstpass=.false.
          kkf = int(.5d0+dmod(time,dtkfil)/dtcont)
         if (kkf .eq. 0) kkf=int(.5d0+dtkfil/dtcont)
c Initialize the science gyros, if not restart run.
         if (.not. rs_flag) then
            do jqyro = 1,4
             h(1,jgyro) = 0.d0
             h(2,jgyro) = 0.d0
             h(3,jgyro) = h0
            enddo
          endif
  Compute the drift angle
           do jgyro = 1,4
             da_ns(jgyro) = datan(H(1,jgyro)/H(3,jgyro))
cash
             da_ns(jgyro) = datan(H(1,jgyro)/dsqrt(H(2,jgyro)**2
                                                   +H(3,jgyro)**2))
             da_ew(jgyro) = datan(H(2,jgyro)/H(3,jgyro))
cash
           enddo
       endif
  Cycle over all four SG's
       do jgyro = 1,4
  Convert gravity gradient forces/torques from body to inertial frame vectors
           call botoin(fsg_gg(1,jgyro), fsg_ggi(1,jgyro),1)
           call botoin(fsg_j2_gg(1,jgyro), fsg_j2_ggi(1,jgyro),1)
           call botoin(tsg_gg(1,jgyro), tsg_ggi(1,jgyro),1)
           call botoin(tsg_j2_gg(1,jgyro), tsg_j2_ggi(1,jgyro),1)
           call intobo(facti(1,2+jgyro), factb(1,jgyro),1)
c Compute the force vector on the SG rotor (GG + J2 term)
           Hmag = ufmag(H(1,jgyro))
           do i = 1,3
             uh(i,jgyro) = H(i,jgyro)/Hmag
             H(i,jgyro) = uh(i,jgyro)*H0
           enddo
  Compute the drift angle
           da_ns(jgyro) = datan(H(1,jgyro)/
                dsqrt(H(2,jgyro)**2 + H(3,jgyro)**2))
           da_ew(jgyro) = datan(H(2,jgyro)/H(3,jgyro))
           do i = 1,3
             xcm2cg(i) = uh(i,jgyro)*d
             Fsg_rotor(i,jgyro) = facti(i,2+jgyro)
Fsg_rotorb(i) = factb(i,jgyro)
             Fsg_rotorb(i)
           enddo
           tli(1) =-d*(Fsg_rotor(2,jgyro)+Fsg_rotor(3,jgyro)*da_ew(jgyro))
           tli(2) = d*(Fsg_rotor(1,jgyro)-Fsg_rotor(3,jgyro)*da_ns(jgyro))
           t1i(3) = 0.d0
           t2i(1) = -deltar*dcos(elect_half)/preload_acc*
                  ((Fsg_rotorb(2)**2 - (Fsg_rotorb(1)**2 +
                   Fsg_rotorb(3)**2)/2.d0)
                   (da_ns(jgyro)*dsin(2.d0*st_roll)
                   + da_ew(jgyro)*dcos(2.d0*st_roll) + da_ew(jgyro))
                   - 2.d0*Fsg_rotorb(1)*Fsg_rotorb(3)
                   *dsin(st_roll))
           t2i(2) = -deltar*dcos(elect_half)/preload_acc*
```

```
æ
                  ((Fsg_rotorb(2)**2 - (Fsg_rotorb(1)**2 +
      &
                   Fsg_rotorb(3) • *2) /2.d0)
      æ
                   *(da_ew(jgyro)*dsin(2.d0*st_roll)
                   - da_ns(jgyro)*dcos(2.d0*st_roll) + da_ns(jgyro))
      æ
                   + 2.d0*Fsg_rotorb(1)*Fsg_rotorb(3)
                   *dcos(st_roll))
           t2i(3) = 0.d0
           do i = 1,3
              T_per(i) = t1i(i) + t2i(i)
 c Compute the torque perpendicular to the Momentum vector total
   Compute the new momentum vector and normalize to the original magnitude
           do i = 1,3
   this is odd H(i,jgyro) = H(i,jgyro) + (T_per(i))*dtcont
   this is direct
                              H(i,jgyro) = H(i,jgyro)
C
      æ
                    + (tsg_ggi(i,jgyro)+tsg_j2_ggi(i,jgyro))*dtcont
C
   this is direct and odd
                                      H(i,jgyro) = H(i,jgyro) + (T_per(i)
C
      æ
                          +tsg_ggi(i,jgyro)+tsg_j2_ggi(i,jgyro))*dtcont
              H(i,jgyro) = H(i,jgyro) + (T_per(i)
                         +tsg_ggi(i,jgyro)+tsg_j2_ggi(i,jgyro))*dtcont
           enddo
        enddo
   Compute SQUID noise in pitch and yaw
        do i = 1,2
           serr_p(i) = 0.d0
           serr_y(i) = 0.d0
  Compute Science Gyro Output angles
        sg_1 = -da_ew(1)*dsin(st_roll) + da_ns(1)*dcos(st_roll) - serr_p(1)
        sg_2 = -da_ew(2)*dsin(st_roll) + da_ns(2)*dcos(st_roll) - serr_p(2)
        sg_3 = da_ew(3)*dcos(st_roll) + da_ns(3)*dsin(st_roll) - serr_y(1)
        sg_4 = da_ew(4)*dcos(st_roll) + da_ns(4)*dsin(st_roll) - serr_y(2)
C Convert Science Gyro outputs from radians to counts
cash Output Kalman filter data to kalfil.out every 8.60sec
        if (kkf .eq. 86) then
cash
cash
      Calculate pointing vector of star tracker
           call vcross(fp1i, fp2i, st_vec)
           call unit(st_vec,ust_vec,ier)
cash
cash
      Calculate pointing error (star tracker only)
             perr=atan2(ust_vec(1), ust_vec(3))-atan2(uh(1,4), uh(3,4))
cash
           perr=atan2(dsin(st_pitch)*dcos(st_roll),dcos(st_pitch))
cash
cash
      Calculate the body attitude wrt inertial (312 rotation)
cash
             thet1= dasin( ctrans(2,3,1))
cash
             thet2=datan2(-ctrans(1,3,1),ctrans(3,3,1))
cash
             thet3=datan2(-ctrans(2,1,1),ctrans(2,2,1))
           thet1= dasin( ctrans(3,2,1))
           thet2=datan2(-ctrans(3,1,1),ctrans(3,3,1))
           thet3=datan2(-ctrans(1,2,1),ctrans(2,2,1))
cash
cash
      Convert Angular Momentum vector to body and define squid outputs
          call intobo(UH(1,4), Hbody, 1)
          squid_x = -Hbody(2)
          squid_y = Hbody(1)
cash
cash
      Convert Science Telescope Measurement to body and define tel. outputs
      (science telescope is sensor #4)
cash
          call intobo(USI(1,4),tele_body,1)
          tele_x = -tele_body(2)
          tele_y = tele_body(1)
cash
     Output the current velocity aberration angles in inertial frame (star frame)
cash
```

```
cjrg Z along GS, X in plane, south, Y completes RHS.
         vab_x = -VABER(2)
          vab_y = VABER(1)
         kkf = 1
       else
         kkf = kkf + 1
       endif
       return
       end
subroutine gg_body(time,t_sp_gg, t_j2_gg, f_sp_gg, f_j2_gg,bona)
CC
CC
   Function: Compute gravity gradient torques due to
CC
              spherical earth and J2 oblateness term.
CC
   Source: JC; JG notes
CC
                                  Date: 12/18/90
CC
   Output: t_sp_gg - grav grad body torque vector due
CC
CC
                     to sperical earth model.
CC
            t_j2_gg -
                     grav grad body torque vector due
CC
                     to J2 term only (Nt-m).
CC
   Comments: Real*8
CC
CC
             Requires data available in common declarations
CC
              from initialization subroutine.
CC
implicit none ! double precision (a-h,o-z)
cc Include transformation data
      save
      include 'DBP.F'
      include 'DBB.F'
      real*8 time, omeglvsq
                             !sim time; angles
      real*8 body_ti(3,3)
                              !TREETOPS inertial to body trans
      real*8 ti_prime(3,3), body_prime(3,3)
      real*8 t_sp_gg(3)
                              !spherical earth grav grad torques
      real*8 s(3,3)
                               !dvadic
      real*8 t_j2_gg(3)
                               !J2 gravity gradient torques
      real*8 gme
                              !grav constant x earth's mass
      real*8 re
                              !earth's equatorial radius
      real*8 j2
                              !J2 oblate earth term
      real*8 rig_dec
C
                              !Rigel declination angle (deg)
      real*8 ti_eci(3,3)
                             !orbit plane eci to TREETOPS i frame
      real*8 body_eci(3,3)
                             !ECI to BODY trans
      real*8 ur_prime(3)
                              !unit vector from veh CM to earth CM
      real*8 ur_body(3)
      real*8 ua_eci(3)
                             !unit vector from earth CM to N pole
      real*8 ua_body(3)
      real*8 temp1(3), temp2(3), t1, t2
      real*8 temp3(3)
      real*8 bona(3,3)
                               !TT body from nadir transform
      real*8 d_dot
      real*8 pi,ro,traci,ufmag
      integer i, j, jgyro
      logical pass_flag
      parameter(pi = 3.1415926535897932384d0)
      parameter(gme = 3.986032d5)
                                       !Km^3 sec^-2
      parameter ( re = 6.378165d3 )
                                       ! Km
      parameter(j2 = 1.08263d-3)
     parameter( rig_dec = -8.21666667d0*pi/180.d0 )
      parameter( ro = re + 650.0 )
                                       !Km; 650 Km orbit alt
      parameter(omeglvsq = gme / ro**3)
                                        !gg force and torque constant
      INCLUDE 'XFRM.F'
     common / CSCI2ECI / CLE
```

cash cash

cash

2

3

1

2

3

Date: 14 February 2003 Contract No.: NAS8-00114 real\*8 w\_orbit, w\_roll !orbit rate; roll rate (rad/sec) common / rates / w\_orbit, w\_roll real\*8  $i_body(3,3)$ !body inertia dyadic common / ggfeedf / i\_body real\*8 uec2sc\_b(3), ucm2pm\_b(3), cm2pm\_b(3), t3 real\*8 f\_sp\_gg(3), f\_j2\_gg(3) real\*8 alf,g\_alpha,h\_alpha,rpvec(3),d\_ov\_rp(3),dsg2pm,rpd(3),rpdm c Science gyro GG force calculation variables  $real*8 fsg_gg(3,4)$ ,  $sg2pm_b(3,4)$ ,  $tsg_j2_gg(3,4)$ ,  $i_sg(3,3)$ real\*8 usg2pm\_b(3,4), fsg\_j2\_gg(3,4), tsg\_gg(3,4), s\_sg(3,3) common / sg\_gg / fsg\_gg, tsg\_j2\_gg, fsg\_j2\_gg, tsg\_gg data sg2pm\_b / 0.0d0, 0.0d0, 0.00000d0, 0.0d0, 0.0d0, 0.08250d0, 0.0d0, 0.0d0, 0.16500d0, 0.0d0, 0.0d0, 0.24750d0 / data usg2pm\_b , 0.0d0, 0.0d0, 1.0d0, 0.0d0, 0.0d0, 1.0d0, 0.0d0, 0.0d0, 1.0d0, 0.0d0, 0.0d0, 1.0d0 / data i\_sg / 9\*0.0d0 /

C Worse case center of mass to proof mass vector (meters) data cm2pm\_b / 0.0d0, 0.0d0, -0.1816d0 / data ucm2pm\_b / 0.0d0, 0.0d0, -1.d0 / data ua\_eci / 0., 1., 0. /

data ur\_prime / 0., 0., 1. / data pass\_flag / .true. / cjrg This calculation uses control system estimated value of orbit rate cjrg This is incorrect and becomes significantly so over long times. Replaced

cjrg by correct value, csi\_l transformation. jrg 12-29-97

cc Compute trans from PRIME to TI based on nominal orbit rate and simulation time. CC orb = w\_orbit \* time С С call d\_rot(2, -orb, ti\_prime)

cc Use trans TI to BODY from TREETOPS code

cjrg Also use csi\_1 from treetops. Use local vertical sensor to define csi\_1. cjrg bona is body from nadir.

do i=1,3cjrg cjrg do j=1,3cjrg  $ti_prime(i,j) = csi_1(i,j)$ cjrg ti\_prime(i,j) = bona(j,i) cjrg body\_ti(i,j) = ctrans(j,i,1) cjrg enddo enddo cjrg

cc Compute unit vector from body CM to earth CM expressed in body cjrg Prime frame is local vertical frame.

call d\_mmul(body\_ti, ti\_prime, body\_prime, 3, 3, 3) cjrg  $body_prime(1,1) = bona(1,1)$  $body_prime(1,2) = bona(1,2)$  $body_prime(1,3) = bona(1,3)$  $body_prime(2,1) = bona(2,1)$  $body_prime(2,2) = bona(2,2)$  $body_prime(2,3) = bona(2,3)$  $body_prime(3,1) = bona(3,1)$  $body_prime(3,2) = bona(3,2)$  $body_prime(3,3) = bona(3,3)$ 

call d\_mxv(body\_prime, ur\_prime, ur\_body)

if (pass\_flag) then

```
pass_flag = .false.
     Transformation from TREETOPS ECI frame to the on-orbit
      spacecraft inertial frame (SI); computed at time=0 in TT code
 CC
            do j=1,3
 c
              ti_eci(i,j) = cle(i,j)
              ti_eci(i,j) = csi_eci(i,j)
            enddo
          enddo
 cc Compute S = dyadic defined by (1/2 trace II) I - II) where II
     is the moment of inertia dyadic and I is the identity matrix.
С
          call trace(i_body, traci, 3)
          traci = i_body(1,1) + i_body(2,2) + i_body(3,3)
          do i=1,3
            do j=1,3
              if(i .eq. j) then
                s(i,j) = 0.5d0*traci - i_body(i,j)
              else
                s(i,j) = -i_body(i,j)
              endif
            enddo
          enddo
c ***** for SG *****
        i_sg(1,1) = 9.1999324D-6
cash
cash
        i_sg(2,2) = 9.1999540D-6
          i_sg(1,1) = 9.1999432D-6
          i_sg(2,2) = 9.1999432D-6
          i_sg(3,3) = 9.2000000D-6
C
        call trace(i_sg, traci, 3)
          traci = i_sg(1,1) + i_sg(2,2) + i_sg(3,3)
          do i=1,3
            do j=1,3
              if(i .eq. j) then
                s_sg(i,j) = 0.5*traci - i_sg(i,j)
              else
                s_sg(i,j) = -i_sg(i,j)
              endif
            enddo
          enddo
c ***** for SG *****
        endif
cc Compute gravity grad torque terms; several
     (axS.b) terms in expansion; a,b = unit vectors,
     S = dyadic defined by (1/2 trace II) I - II) where II is the
     moment of inerita dyadic and I is the identity matrix.
       call d_mmul(body_ti, ti_eci, body_eci, 3, 3, 3)
call d_mmv(body_eci, ua_eci, ua_body)
        t1 = d_dot(ua_body, ur_body)
       call dyad_xd(ur_body, s, ua_body, temp1)
       call dyad_xd(ua_body, s, ur_body, temp2)
cash
cash addition from Kasdin paper page 8
       call dyad_xd(ua_body, s, ua_body, temp3)
       do i=1.3
         temp1(i) = temp1(i) + temp2(i)
       enddo
       t2 = d_dot(ua_body, ur_body)
       t2 = 0.5d0 * (7.d0 * (t2**2) - 1.d0)
С
       t2 = 3.5d0 \cdot (t2**2) - 0.5d0
```

TCD20030028A Contract No.: NAS8-00114 call dyad\_xd(ur\_body, s, ur\_body, temp2) do i=1,3cc Compute grav grad torque vector due to J2 term  $t_j2_g(i) = (gme * 15. * j2 * (re**2) / (ro**5)) *$ (-t1 \* temp1(i) + t2 \* temp2(i)+0.2d0 \* temp3(i)) æ cc Compute grav grad torque vector for spherical earth model  $t_{sp_gq(i)} = -3. * omeglvsq * temp2(i)$ enddo cc Compute the gravity gradient force on the main body  $uec2sc_b(1) = -ur_body(1)$  $uec2sc_b(2) = -ur_body(2)$  $uec2sc_b(3) = -ur_body(3)$  $t3 = d_dot(uec2sc_b, cm2pm_b)$ do i = 1,3enddo cc Compute the gravity gradient J2 force on the vehicle (body 1) t1 = d\_dot(ur\_body, ucm2pm\_b) t2 = d\_dot(ur\_body, ua\_body) t3 = d\_dot(ucm2pm\_b, ua\_body) do i=1,3 $f_{j2}gg(i) = 1.5D0 * omeglvsq * BMASS(1) *j2 * (re/ro)**2 *$ ufmag(cm2pm\_b) • ( ucm2pm\_b(i) -  $5.0d0*t1*ur_body(i)$  -5.0d0\*t2\*\*2\*ucm2pm\_b(i) - (10.0d0\*t2\*t3 - 35.0d0\*t1\*t2\*\*2)
\*ur\_body(i) + (2.0d0\*t3 - 10.0d0\*t2\*t1)\*ua\_body(i) ) cc Compute the gravity gradient spherical and J2 torque on the SG (body 3) call dyad\_xd(ur\_body, s\_sg, ua\_body, temp1) call dyad\_xd(ua\_body, s\_sg, ur\_body, temp2) cash cash addition from Kasdin paper page 8 call dyad\_xd(ua\_body, s\_sg, ua\_body, temp3) cash do i=1,3templ(i) = templ(i) + temp2(i)enddo t2 = d\_dot(ua\_body, ur\_body) t2 = 0.5 \* (7.e0 \* (t2\*\*2) - 1.e0)c t2 = 3.5d0 \* (t2\*\*2) - 0.5d0call dyad\_xd(ur\_body, s\_sg, ur\_body, temp2) t1 = d\_dot(ua\_body, ur\_body) do jgyro=1,4 do i=1,3 $tsg_j2_gg(i,jgyro) = (15.d0 * omeglvsq * j2*(re / ro)**2)*$ (-t1 \* temp1(i) + t2 \* temp2(i)æ +0.2d0 • temp3(i)) Compute grav grad torque vector for spherical earth model  $tsg_g(i,jgyro) = -3. * omeglvsq * temp2(i)$ enddo cc Compute the gravity gradient force on the science gyro (body 3) do jgyro = 1.4 $t3 = d_dot(uec2sc_b, sg2pm_b(1,jgyro))$ do i = 1.3fsg\_gg(i,jgyro) = omeglvsq\*BMASS(2+jgyro) \*  $(sg2pm_b(i,jgyro) - 3.0d0*t3*uec2sc_b(i))$ enddo

Date: 14 February 2003

cc Compute the gravity gradient J2 force on the science gyro (body 3)

enddo

bd Systems® TCD20030028A

```
do jgyro = 1,4
      t1 = d_dot(ur_body, usg2pm_b(1,jgyro))
      t2 = d_dot(ur_body, ua_body)
      t3 = d_dot(usg2pm_b(1,jgyro), ua_body)
    do i=1,3
       fsg_j2_gg(i,jgyro) = 1.5D0 * omeglvsq * BMASS(2+jgyro)
             • j2 * (re/ro)**2 * ufmag(sg2pm_b(1,jgyro)) *
( usg2pm_b(i,jgyro) - 5.0d0*t1*ur_body(i)
- 5.0d0*t2**2*usg2pm_b(i,jgyro) - (10.0d0*t2*t3
- 35.0d0*t1*t2**2) • ur_body(i) +
&
&
&
&
               (2.0d0*t3 - 10.0d0*t2*t1)*ua_body(i) )
      enddo
   enddo
   return
   end
```

#### Appendix C

#### INPUT FILE DEFINING CONTROL GAINS FOR THE TREETOPS GP-B SIMULATION GAINS.INP

```
.1
                                 ! dt (s) for plotting
10
                                 ! No. of dt's / plot write (data.mat)
50
                                 ! No. of dt's / plot write (control.mat)
1.98,0.482,0.25,0.030,0.00093 ! RV p/y gains kr, kp, ki, kop, koi (.15 Hz BW) 18000.0,0.1,100.0,25.0,5.0,25.0,25.0,0.0 ! RV p/y limits (arcsec)
                                 ! pitch/yaw Inertia (kg-m^2)
                                                                 kr, kp, ki, kop, koi (.06 Hz BW)
14.9227,0.0083371,0.0335059,0.00408,0.0041, ! Roll gains
18000.0,0.1,100.0,25.0,5.0,25.0,25.0,0.0
                                                         ! Roll limits (arcsec)
                                ! Roll Inertia (kg-m^2)
3693.4
1.2435,2.44,0.605
                                 ! translational gains kr, kp, ki (.5 Hz BW)
5.0D-6, 5.D-2, 5.0D-6, 0.005
                                              ! translational limits (m, N)
3182.8
                                ! translational mass (kg)
0.0d0,0.0d0,0.01024d12
                                ! thruster leakage, hysteresis & maximum (N)
1.4,150.0
                                ! Magnetic command hysteresis & maximum (ATM^2)
0.0E0
                                 ! Mass flow rate command (kg/sec)
5230.2, -19.3, 6.0
                              ! body inertia matrix
-19.3, 5147.5, 0.
6.0, 0., 3693.4
1.068387D-3
                                ! orbit rate (rad/sec)
1.80D0
                                ! roll rate (deg/sec)
.false.
                                ! Gravity Gradient feed forwardON (check .INT file also)
.false.
                                ! Cryo feed forward torque ON (check .INT file also)
.true.
                                ! Velocity aberration feed forward ON (check .INT also)
.true.
                                ! Closed loop controller (thrusters enabled)
   5.6443950e+03 1.5239867e+03 1.3715880e+02
                                                      4.1147640e+00
  5.5775970e+03 1.5059512e+03 1.3553561e+02
1.9016563e+03 3.5845377e+02 2.2522314e+01
                                                      4.0660682e+00
4.7170625e-01
```

# Appendix D

# INPUT FILE DEFINING HELIUM THRUSTER MOUNTING LOCATIONS AND FORCE DIRECTIONS FOR THE TREETOPS GP-B SIMULATION THRUSTERS.INP

# Appendix E

# INPUT FILE DEFINING SENSOR AND ACTUATOR NOISE, QUANTIZATION VALUES, FOR THE TREETOPS GP-B SIMULATION ERRORS.INP

| 21 !                | roll Star Tracker noise seed                               |
|---------------------|------------------------------------------------------------|
| 22, 23 !            | pitch & yaw Science Telescope noise seeds                  |
|                     | Control Gyro (roll, pitch, yaw) noise seeds                |
| 27, 28, 29 !        | Drag Free Sensor (x, y, z) noise seeds                     |
| 1,2,3,4,5,6,7,8,9,1 | 0,11,12,13,14,15,16 ! 16 Thruster noise seeds              |
| 5.0d0 !             | roll Star Tracker noise standard deviation (Arcsec)        |
| 22.36d0 !           | ST noise standard deviation (milliArcsec)                  |
| 0.002236d0 !        | Control Gyro noise standard deviation (Arcsec/sec)         |
| 3.354d0 !           | Drag Free Sensor noise standard deviation (nanometers)     |
| 0.0559d0 !          | Thruster noise standard deviation (milliNewtons)           |
| 0.5d0 !             | roll Star Tracker least significant bit (Arcsec)           |
| 0.25d0 !            | ST least significant bit (milliArcsec)                     |
| 375.0d-1 !          | Roll Control Gyro least significant bit (milliArcsec)      |
| 1.3d0 !             | Pitch/Yaw Control Gyro least significant bit (milliArcsec) |
| 1.0d0 !             | Drag Free Sensor least significant bit (nanometers)        |
| 0.0025d0 !          | Thruster least significant bit (milliNewtons)              |
| 0.000d0, 0.000d0, 0 | .000d0 ! Control Gyro drift (r, p, y) (Arcsec/sec)         |

# Appendix F

# INPUT FILE DEFINING MODEL FOR THE TRANSFER FUNCTION APPROACH TO SLOSH DYNAMICS ANALYSIS IMPEG\_GPB\_TF.INT

TREETOPS REV 10X 1/10/02

#### SIM CONTROL

| SI | 0 Title                                                          | GPB MODEL FOR 2002 |
|----|------------------------------------------------------------------|--------------------|
| SI | 0 Simulation stop time                                           | 20000              |
| SI | 0 Plot data interval                                             | 5                  |
| SI | 0 Integration type (R,S or U)                                    | R                  |
| SI | 0 Step size (sec)                                                | 0.10               |
| SI | O Sandia integration absolute and relative error                 |                    |
| SI | 0 RK78 ODE solver absolute error and first step size             |                    |
| SI | 0 Linearization option (L,Z or N)                                | N                  |
| SI | 0 Restart option (Y/N)                                           | N                  |
| SI | 0 Contact force computation option (Y/N)                         | N                  |
| SI | 0 Constraint force computation option (Y/N)                      | N                  |
| SI | O Small angle speedup option (All, Bypass, First, Nth)           | A                  |
| SI | 0 Mass matrix speedup option (All, Bypass, First, Nth)           | A                  |
| SI | <pre>0 Non-Linear speedup option (All, Bypass, First, Nth)</pre> | A                  |
| SI | O Constraint speedup option (All, Bypass, First, Nth)            | A                  |
| SI | O Constraint stabilization option (Y/N)                          | N                  |
| SI | 0 Stabilization epsilon                                          |                    |

#### GENGRAV

| GG | <pre>2 Gravity, earth sphere/nonsphere/user (S/N/U)?</pre> | N         |
|----|------------------------------------------------------------|-----------|
| GG | 1 Input gravity constants: GME, ERAD, EMASS                |           |
| GG | 1 Spherical or Nonspherical (S/N)?                         |           |
| GG | 1 Gravity Potential Harmonics J2, J3, J4                   |           |
| GG | <pre>2 English (ft-slug-s) or metric (m-kg-s) (E/M)?</pre> | M         |
| GG | 2 Day, Month, Year,                                        | 21 6 2003 |
| GG | 2 GMT & sim time 0 (minutes past midnight,                 | 720       |
| GG | 2 Solar Pressure forces Y/N?                               | N         |
| GG | 2 Input new data for aero model? (Y/N)                     | Y         |
| GG | 2 Solar flux F10 for aero model                            | 230       |
| GG | 2 Solar flux, 81 day average F10B                          | 230       |
| GG | 2 Geomagnetic index, GEAP                                  | 400       |
|    |                                                            |           |

#### BODY

| BO | I Body ID number                                     | 1                    |
|----|------------------------------------------------------|----------------------|
| BO | 1 Type (Rigid, Flexible, NASTRAN)                    | R                    |
| BO | 1 Number of modes                                    |                      |
| BO | 1 Modal calculation option (0, 1 or 2)               |                      |
| BO | 1 Foreshortening Option (Y/N)                        |                      |
| во | 1 Model reduction method (NO,MS,MC,CC,QM,CV)         |                      |
| BO | 1 NASTRAN data file FORTRAN unit number (40 - 60)    |                      |
| BO | 1 Number of augmented nodes (0 if none)              |                      |
| во | 1 Damping matrix option (NS,CD,HL,SD)                |                      |
| BO | 1 Constant damping ratio                             |                      |
| BO | 1 Low frequency, High frequency ratios               |                      |
| BO | 1 Mode ID number, damping ratio                      |                      |
| BO | 1 Conversion factors: Length, Mass, Force            |                      |
| BO | 1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) | 1                    |
| BO | 1 Moments of inertia (kg-m2) Ixx, Iyy, Izz           | 5230.2 5147.5 3693.4 |
| во | 1 Products of inertia (kg-m2) Ixy,Ixz,Iyz            | 19.3 -6 0            |
|    |                                                      |                      |

```
во
     1 Mass (kg)
                                                                         3182.8
BO
     1 Number of Nodes
                                                                        13
     1 Node ID, Node coord. (meters) x,y,z
                                                                        1 0 -0.0002 0.8647
BO
    1 Node ID, Node coord. (meters) x,y,z
                                                                        2 0 -0.0002 0.8647
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        3 0 1.0467 0.6380
BO 1 Node ID, Node coord. (meters) x,y,z
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        4 0 0 0.10033
                                                                        5 -1.19 0 2.51
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        6 1.19 0 2.51
BO 1 Node ID, Node coord. (meters) x,y,z
BO 1 Node ID, Node coord. (meters) x,y,z
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        7 -1.19 0 -1.9
                                                                        8 1.19 0 -1.9
                                                                        9 0 0 -.10033
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        10 0 0 -.18283
    1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                        11 0 0 -.26533
BO
BO
                                                                        12 0 0 -.34783
BO 1 Node ID, Node coord. (meters) x,y,z
                                                                        13 0 0 0.10937
BO 1 Node ID, Node structual joint ID
BO
     2 Body ID number
                                                                        2
     2 Type (Rigid, Flexible, NASTRAN)
BO
BO
     2 Number of modes
BO
     2 Modal calculation option (0, 1 or 2)
    2 Foreshortening Option (Y/N)
BO
BO 2 Model reduction method (NO, MS, MC, CC, QM, CV)
BO
     2 NASTRAN data file FORTRAN unit number (40 - 60)
BO
     2 Number of augmented nodes (0 if none)
     2 Damping matrix option (NS,CD,HL,SD)
BO
     2 Constant damping ratio
BO
     2 Low frequency, High frequency ratios
     2 Mode ID number, damping ratio
BO
     2 Conversion factors: Length, Mass, Force
     2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
BO
                                                                         .00001 .00001 .00001
BO
     2 Moments of inertia (kg-m2) Ixx, Iyy, Izz
     2 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                        0 0 0
BO
     2 Mass (kg)
                                                                        .076
     2 Number of Nodes
во
     2 Node ID, Node coord. (meters) x,y,z
                                                                        1000
BO
     2 Node ID, Node structual joint ID
     3 Body ID number
     3 Type (Rigid, Flexible, NASTRAN)
                                                                        R
во
    3 Number of modes
     3 Modal calculation option (0, 1 or 2)
во
     3 Foreshortening option (Y/N)
    3 Model reduction method (NO, MS, MC, CC, QM, CV)
    3 NASTRAN data file FORTRAN unit number (40 - 60)
BO
     3 Number of augmented nodes (0 if none)
     3 Damping matrix option (NS,CD,HL,SD)
RΩ
     3 Constant damping ratio
ВО
     3 Low frequency, High frequency ratios
     3 Mode ID number, damping ratio
     3 Conversion factors: Length, Mass, Force
BO
     3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                        9.1999324E-6 9.199954E-6 9.2E-6
     3 Moments of inertia (kg-m2) Ixx, Iyy, Izz
BO
     3 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                        0 0 0
     3 Mass (kg)
                                                                        0.06335
BO
BO
     3 Number of Nodes
     3 Node ID, Node coord. (meters) x,y,z
                                                                        1000
                                                                        2 0 0 -5.08E-8
     3 Node ID, Node coord. (meters) x,y,z
BO
     3 Node ID, Node structual joint ID
во
     4 Body ID number
     4 Type (Rigid, Flexible, NASTRAN)
BO
BO
     4 Number of modes
     4 Modal calculation option (0, 1 or 2)
BO
     4 Foreshortening option (Y/N)
во
     4 Model reduction method (NO, MS, MC, CC, QM, CV)
     4 NASTRAN data file FORTRAN unit number (40 - 60)
BO
во
     4 Number of augmented nodes (0 if none)
     4 Damping matrix option (NS,CD,HL,SD)
BO
     4 Constant damping ratio
BO
     4 Low frequency, High frequency ratios
```

Date: 14 February 2003
Contract No.: NAS8-00114

CCe
Prm; 1=mass cen) 1

```
4 Mode ID number, damping ratio
     BO 4 Conversion factors: Length, Mass, Force
     BO
          4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
     BO
          4 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                          9.1999324E-6 9.199954E-6 9.2E-6
     BO 4 Products of inertia (kg-m2) Ixy,Ixz,Iyz
                                                                          0 0 0
     BO 4 Mass (kg)
                                                                         .06335
     во
          4 Number of Nodes
                                                                         2
     BO 4 Node ID, Node coord. (meters) x,y,z
                                                                          1 0 0 0
     BO 4 Node ID, Node coord. (meters) x,y,z
                                                                         2 0 0 -5.08E-8
     BO 4 Node ID, Node structual joint ID
     BO
          5 Body ID number
                                                                         5
     BO 5 Type (Rigid, Flexible, NASTRAN)
          5 Number of modes
     BO
     во
          5 Modal calculation option (0, 1 or 2)
     BO 5 Foreshortening option (Y/N)
     BO 5 Model reduction method (NO, MS, MC, CC, QM, CV)
          5 NASTRAN data file FORTRAN unit number (40 - 60)
     BO
     BO 5 Number of augmented nodes (0 if none)
     BO 5 Damping matrix option (NS,CD,HL,SD)
     BO 5 Constant damping ratio
     BO
          5 Low frequency, High frequency ratios
     BO 5 Mode ID number, damping ratio
     BO 5 Conversion factors: Length, Mass, Force
          5 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
     во
     BO 5 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                          9.1999324E-6 9.199954E-6 9.2E-6
     BO 5 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                         0 0 0
     BO
         5 Mass (kg)
                                                                         .06335
     BO
          5 Number of Nodes
                                                                         2
     BO 5 Node ID, Node coord. (meters) x,y,z
                                                                         1 0 0 0
     BO 5 Node ID, Node coord. (meters) x,y,z
                                                                         2 0 0 -5.08E-8
     BO 5 Node ID, Node structual joint ID
         6 Body ID number
     BO
                                                                         6
     BO 6 Type (Rigid, Flexible, NASTRAN)
                                                                         R
     BO
         6 Number of modes
     BO 6 Modal calculation option (0, 1 or 2)
     BO 6 Foreshortening option (Y/N)
     BO
         6 Model reduction method (NO, MS, MC, CC, QM, CV)
          6 NASTRAN data file FORTRAN unit number (40 - 60)
     BO
     BO
          6 Number of augmented nodes (0 if none)
     BO
         6 Damping matrix option (NS,CD,HL,SD)
         6 Constant damping ratio
     BO
     BO
         6 Low frequency, High frequency ratios
         6 Mode ID number, damping ratio
     BO
         6 Conversion factors: Length, Mass, Force
     BO
          6 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
          6 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                         9.1999324E-6 9.199954E-6 9.2E-6
          6 Products of inertia (kg-m2) Ixy,Ixz,Iyz
     во
                                                                         0 0 0
     BO
         6 Mass (kg)
                                                                         .06335
     BO
         6 Number of Nodes
                                                                         2
     BO
         6 Node ID, Node coord. (meters) x,y,z
                                                                         1 0 0 0
         6 Node ID, Node coord. (meters) x,y,z
                                                                         2 0 0 -5.08E-8
         6 Node ID, Node structual joint ID
     BO
            HINGE
        1 Hinge ID number
         1 Inboard body ID, Outboard body ID
1 "p" node ID, "q" node ID
     HI
                                                                         0 1
     HI
         1 Number of rotation DOFs, Rotation option (F or G)
                                                                         3 F
     нт
         1 L1 unit vector in inboard body coord. x,y,z
                                                                         0 1 0
        1 L1 unit vector in outboard body coord. x,y,z
1 L2 unit vector in inboard body coord. x,y,z
     HI
         1 L2 unit vector in outboard body coord. x,y,z
         1 L3 unit vector in inboard body coord. x,y,z
     HT
                                                                         0 0 1
          1 L3 unit vector in outboard body coord. x,y,z
                                                                         0 0 1
     ΗI
        1 Initial rotation angles (deg) -16.7408 16.8411 -90 -16.739107675801 16.838172287528
    HI
-90.0
                                                                         0 0 1.8
        1 Initial rotation rates (deg/sec)
```

```
1 Rotation stiffness (newton-meters/rad)
                                                                    0 0 0
 HI 1 Rotation damping (newton-meters/rad/sec)
 HI 1 Null torque angles (deg)
                                                                    0 0 0
 ΗI
     1 Number of translation DOFs
 HI 1 First translation unit vector g1
                                                                    1 0 0
 HI 1 Second translation unit vector g2
                                                                   0 1 0
HI 1 Third translation unit vector g3
     1 Initial translation (meters)
 HI
                                                                    2021331.3322 0 -6720778.19992
HI 1 Initial translation velocity (meters/sec)
                                                                  0 -7533.0 0
HI 1 Translation stiffness (newtons/meters)
                                                                   0 0 0
ΗI
     1 Translation damping (newtons/meter/sec)
                                                                    0 0 0
HI 1 Mull force translations
                                                                    0 0 0
HT
     2 Hinge ID number
                                                                    2
     2 Inboard body ID, Outboard body ID
2 "p" node ID, "q" node ID
                                                                    1 2
ΗI
HI
                                                                    4 1
     2 Number of rotation DOFs, Rotation option (F or G)
ΗI
     2 L1 unit vector in inboard body coord. x,y,z
                                                                   1 0 0
ΗI
     2 L1 unit vector in outboard body coord. x,y,z
                                                                    1 0 0
     2 L2 unit vector in inboard body coord. x,y,z
     2 L2 unit vector in outboard body coord. x,y,z
     2 L3 unit vector in inboard body coord. x,y,z
                                                                    0 0 1
HI 2 L3 unit vector in outboard body coord. x,y,z
                                                                   0 0 1
HI 2 Initial rotation angles (deg)
    2 Initial rotation rates (deg/sec)
ΗI
ΗI
     2 Rotation stiffness (newton-meters/rad)
HI 2 Rotation damping (newton-meters/rad/sec)
HI 2 Null torque angles (deg)
     2 Number of translation DOFs
HI 2 First translation unit vector g1
                                                                   1 0 0
HI 2 Second translation unit vector g2
    2 Third translation unit vector g3
HI
                                                                    0 0 1
     2 Initial translation (meters)
HI 2 Initial translation velocity (meters/sec)
                                                                   0 0 0
    2 Translation stiffness (newtons/meters)
     2 Translation damping (newtons/meter/sec)
                                                                   0 0 0
    2 Null force translations
                                                                    0 0 0
    3 Hinge ID number
                                                                    3
     3 Inboard body ID, Outboard body ID
3 "p" node ID, "q" node ID
ΗI
                                                                   1 3
ΗI
                                                                    9 2
    3 No of rotation DOFs, Hinge 1 rotation option(F/G)
    3 L1 unit vector in inboard body coord. x,y,z
                                                                   1 0 0
     3 L1 unit vector in outboard body coord. x,y,z
    3 L2 unit vector in inboard body coord. x,y,z
    3 L2 unit vector in outboard body coord. x,y,z
     3 L3 unit vector in inboard body coord. x,y,z
3 L3 unit vector in outboard body coord. x,y,z
                                                                   0 0 1
                                                                   0 0 1
    3 Initial rotation angles (deg)
     3 Initial rotation rates (deg/sec)
    3 Rotation stiffness (newton-meters/rad)
    3 Rotation damping (newton-meters/rad/sec)
    3 Null torque angles (deg)
    3 Number of translation DOFs
ΗI
    3 First translation unit vector g1
HI
    3 Second translation unit vector g2
                                                                   0 1 0
    3 Third translation unit vector g3
    3 Initial translation (meters)
                                                                   0 0 0
    3 Initial translation velocity (meters/sec)
                                                                   0 0 0
    3 Translation stiffness (newtons/meters)
                                                                   10. 10. 10.
    3 Translation damping (newtons/meter/sec)
                                                                   1.125 1.125 1.125
    3 Null force translations
                                                                   0 0 0
    4 Hinge ID number
    4 Inboard body ID, Outboard body ID
                                                                   1 4
    4 "p" node ID, "q" node ID
HI
    4 Number of rotation DOFs, Rotation option (F or G)
                                                                   0
    4 L1 unit vector in inboard body coord. x,y,z
                                                                   1 0 0
   4 L1 unit vector in outboard body coord. x,y,z
                                                                   1 0 0
HI 4 L2 unit vector in inboard body coord. x,y,z
HI 4 L2 unit vector in outboard body coord. x,y,z
```

| HI                                           | 4 L3 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0 0 1                                                                        |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| HI                                           | 4 L3 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0 0 1                                                                        |
| HI                                           | 4 Initial rotation angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 0 0                                                                        |
| HI                                           | 4 Initial rotation rates (deg/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                              |
| HI                                           | 4 Rotation stiffness (newton-meters/rad)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                              |
| HI                                           | 4 Rotation damping (newton-meters/rad/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                              |
| HI                                           | 4 Null torque angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                                                                            |
| HI                                           | 4 Number of translation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3<br>1 0 0                                                                   |
| HI                                           | 4 First translation unit vector g1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 1 0                                                                        |
| HI                                           | 4 Second translation unit vector g2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 0 1                                                                        |
| HI                                           | 4 Third translation unit vector g3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                              |
| HI                                           | 4 Initial translation (meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0 0 0                                                                        |
| HI                                           | 4 Initial translation velocity (meters/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0 0 0                                                                        |
| HI                                           | 4 Translation stiffness (newtons/meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 10 10 10                                                                     |
| HI                                           | 4 Translation damping (newtons/meter/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1.125 1.125 1.125                                                            |
| HI                                           | 4 Null force translations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 0 0                                                                        |
| ні                                           | 5 Hinge ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 5                                                                            |
| HI                                           | 5 Inboard body ID, Outboard body ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1 5                                                                          |
| HI                                           | 5 "p" node ID, "q" node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 11 2                                                                         |
| HI                                           | 5 Number of rotation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0                                                                            |
| HI                                           | 5 L1 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 0 0                                                                        |
| HI                                           | 5 L1 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 0 0                                                                        |
|                                              | 5 L2 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 100                                                                          |
| HI                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                              |
| HI                                           | 5 L2 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0 0 1                                                                        |
| HI                                           | 5 L3 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0 0 1                                                                        |
| ΗI                                           | 5 L3 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0 0 0                                                                        |
| ΗI                                           | 5 Initial rotation angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 0 0                                                                        |
| HI                                           | 5 Initial rotation rates (deg/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                              |
| HI                                           | 5 Rotation stiffness (newton-meters/rad)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                              |
| HI                                           | 5 Rotation damping (newton-meters/rad/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                              |
| HI                                           | 5 Null torque angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                                                                            |
| HI                                           | 5 Number of translation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3<br>1 0 0                                                                   |
| ΗI                                           | 5 First translation unit vector g1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 1 0                                                                        |
| ΗI                                           | 5 Second translation unit vector g2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 0 1                                                                        |
| HI                                           | 5 Third translation unit vector g3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 0 0                                                                        |
| HI                                           | 5 Initial translation (meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0 0 0                                                                        |
| HI                                           | 5 Initial translation velocity (meters/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 10 10 10                                                                     |
| HI                                           | 5 Translation stiffness (newtons/meters)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.125 1.125 1.125                                                            |
| ΗI                                           | 5 Translation damping (newtons/meter/sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 0 0                                                                        |
| HI                                           | 5 Null force translations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 0 0                                                                        |
| HI                                           | 6 Hinge ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6                                                                            |
| HI                                           | 6 Inboard body ID, Outboard body ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1 6                                                                          |
| HI                                           | 6 "p" node ID, "q" node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 12 2                                                                         |
| HI                                           | 6 Number of rotation DOFs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0                                                                            |
| HI                                           | 6 L1 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 100                                                                          |
| HI                                           | 6 L1 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 0 0                                                                        |
| HI                                           | 6 L2 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                              |
| HI                                           | 6 L2 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                              |
| HI                                           | 6 12 DOLE VECEUE IN OULDOWIN DOUG COOLS, X.V.Z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                              |
|                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 0 1                                                                        |
| HT                                           | 6 L3 unit vector in inboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0 0 1<br>0 0 1                                                               |
| HI<br>Hī                                     | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                              |
| HI                                           | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg)                                                                                                                                                                                                                                                                                                                                                                                                              | 0 0 1                                                                        |
| HI<br>HI                                     | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0 0 1                                                                        |
| HI<br>HI                                     | <pre>6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad)</pre>                                                                                                                                                                                                                                                                                                                       | 0 0 1                                                                        |
| HI<br>HI<br>HI                               | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec)                                                                                                                                                                                                                                                                                       | 0 0 1                                                                        |
| HI<br>HI<br>HI<br>HI                         | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg)                                                                                                                                                                                                                                                            | 0 0 1                                                                        |
| HI<br>HI<br>HI<br>HI                         | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs                                                                                                                                                                                                                               | 0 0 1 0 0                                                                    |
| HI<br>HI<br>HI<br>HI<br>HI                   | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1                                                                                                                                                                                            | 0 0 1 0 0 0                                                                  |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI             | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2                                                                                                                                                        | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0                                        |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI             | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2 6 Third translation unit vector g3                                                                                                                     | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0<br>0 0 1                               |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI       | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2 6 Third translation unit vector g3 6 Initial translation (meters)                                                                                      | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0                                        |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI       | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2 6 Third translation unit vector g3 6 Initial translation (meters) 6 Initial translation velocity (meters/sec)                                          | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0<br>0 0 1<br>0 0 0<br>0 0 0             |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2 6 Third translation unit vector g3 6 Initial translation (meters) 6 Initial translation velocity (meters/sec) 6 Translation stiffness (newtons/meters) | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0<br>0 0 1<br>0 0 0<br>0 0 0<br>10 10 10 |
| HI<br>HI<br>HI<br>HI<br>HI<br>HI<br>HI       | 6 L3 unit vector in inboard body coord. x,y,z 6 L3 unit vector in outboard body coord. x,y,z 6 Initial rotation angles (deg) 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad) 6 Rotation damping (newton-meters/rad/sec) 6 Null torque angles (deg) 6 Number of translation DOFs 6 First translation unit vector g1 6 Second translation unit vector g2 6 Third translation unit vector g3 6 Initial translation (meters) 6 Initial translation velocity (meters/sec)                                          | 0 0 1<br>0 0 0<br>3<br>1 0 0<br>0 1 0<br>0 0 1<br>0 0 0<br>0 0 0             |

SENSOR

SE 1 Sensor ID number

```
1 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
           1 Mounting point body ID, Mounting point node ID
           1 Second mounting point body ID, Second node ID
      SE
           1 Input axis unit vector (IA) x,y,z
                                                                                 0 0 1
           1 Mounting point Hinge index, Axis index
           1 First focal plane unit vector (Fp1) x,y,z
           1 Second focal plane unit vector (Fp2) x,y,z
           1 Sun/Star unit vector (Us) x,y,z
           1 Velocity Aberration Option (Y/N)
      SE
           1 Euler Angle Sequence (1-6)
           1 CMG ID number and Gimbal number
          1 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
           2 Sensor ID number
            2 \  \, \texttt{Type} \, (\texttt{G}, \texttt{R}, \texttt{AN}, \texttt{V}, \texttt{P}, \texttt{AC}, \texttt{T}, \texttt{I}, \texttt{SU}, \texttt{ST}, \texttt{L}, \texttt{IM}, \texttt{P3}, \texttt{V3}, \texttt{CR}, \texttt{CT}, \texttt{ET}, \texttt{LV}, \texttt{A3}, \texttt{FM}) \\
                                                                                 1 3
           2 Mounting point body ID, Mounting point node ID
           2 Second mounting point body ID, Second node ID
           2 Input axis unit vector (IA) x,y,z
                                                                                 0 1 0
          2 Mounting point Hinge index, Axis index
     SE
           2 First focal plane unit vector (Fp1) x,y,z
     SE
           2 Second focal plane unit vector (Fp2) x,y,z
     SE
           2 Sun/Star unit vector (Us) x,y,z
           2 Velocity Aberration Option (Y/N)
     SE
           2 Euler Angle Sequence (1-6)
           2 CMG ID number and Gimbal number
           2 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
     SE
           3 Sensor ID number
                                                                                 3
     SE
           3 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
           3 Mounting point body ID, Mounting point node ID
                                                                                 1 3
           3 Second mounting point body ID, Second node ID
           3 Input axis unit vector (IA) x,y,z
                                                                                 1 0 0
           3 Mounting point Hinge index, Axis index
     SE
           3 First focal plane unit vector (Fp1) x,y,z
           3 Second focal plane unit vector (Fp2) x,y,z
     SE
     SE
           3 Sun/Star unit vector (Us) x,y,z
           3 Velocity Aberration Option (Y/N)
     SE
           3 Euler Angle Sequence (1-6)
     SE
           3 CMG ID number and Gimbal number
           3 Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s])
     SE
     SE
           4 Sensor ID number
           4 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
           4 Mounting point body ID, Mounting point node ID
                                                                                1 2
           4 Second mounting point body ID, Second node ID
           4 Input axis unit vector (IA) x,y,z
     SE
           4 Mounting point Hinge index, Axis index
     SE
     SE
           4 First focal plane unit vector (Fp1) x,y,z
           4 Second focal plane unit vector (Fp2) x,y,z
                                                                                 -0.2756889168 0.2897184368
          4 Sun/Star unit vector (Us) x,y,z
     SE
0.9165472429
     SE 4 Velocity Aberration Option (Y/N)
     SE
          4 Euler Angle Sequence (1-6)
        4 CMG ID number and Gimbal number
        4 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
     SE
          5 Sensor ID number
          5 Type (G, R, AN, V, P, AC, T, I, SU, ST, L, IM, P3, V3, CR, CT, ET, LV, A3, FM)
     SE
          5 Mounting point body ID, Mounting point node ID
                                                                                1 4
     SE
          5 Second mounting point body ID, Second node ID
                                                                                2 1
          5 Input axis unit vector (IA) x,y,z
     SE
          5 Mounting point Hinge index, Axis index
          5 First focal plane unit vector (Fp1) x,y,z
5 Second focal plane unit vector (Fp2) x,y,z
     SE
     SE
     SE
          5 Sun/Star unit vector (Us) x,y,z
     SE
          5 Velocity Aberration Option (Y/N)
     SE
          5 Euler Angle Sequence (1-6)
          5 CMG ID number and Gimbal number
     SE
          5 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
     SE
          6 Sensor ID number
                                                                                6
```

```
6 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                    2 1
     6 Mounting point body ID, Mounting point node ID
     6 Second mounting point body ID, Second node ID
                                                                    1 0 0
     6 Input axis unit vector (IA) x,y,z
     6 Mounting point Hinge index, Axis index
     6 First focal plane unit vector (Fp1) x,y,z
     6 Second focal plane unit vector (Fp2) x,y,z
SE
     6 Sun/Star unit vector (Us) x,y,z
     6 Velocity Aberration Option (Y/N)
     6 Euler Angle Sequence (1-6)
     6 CMG ID number and Gimbal number
SE
     6 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                    7
SE
     7 Sensor ID number
     7 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                    AC
     7 Mounting point body ID, Mounting point node ID
                                                                    2 1
     7 Second mounting point body ID, Second node ID
                                                                    0 1 0
SE
     7 Input axis unit vector (IA) x,y,z
SE
     7 Mounting point Hinge index, Axis index
    7 First focal plane unit vector (Fp1) x,y,z
SE
     7 Second focal plane unit vector (Fp2) x,y,z
     7 Sun/Star unit vector (Us) x,y,z
     7 Velocity Aberration Option (Y/N)
SE
     7 Euler Angle Sequence (1-6)
SE
     7 CMG ID number and Gimbal number
SE
     7 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                    8
SE
     8 Sensor ID number
     8 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                    AC
                                                                    2 1
     8 Mounting point body ID, Mounting point node ID
     8 Second mounting point body ID, Second node ID
                                                                    0 0 1
     8 Input axis unit vector (IA) x,y,z
     8 Mounting point Hinge index, Axis index
     8 First focal plane unit vector (Fp1) x,y,z
SE
     8 Second focal plane unit vector (Fp2) x,y,z
     8 Sun/Star unit vector (Us) x,y,z
     8 Velocity Aberration Option (Y/N)
SE
     8 Euler Angle Sequence (1-6)
SE
     8 CMG ID number and Gimbal number
     8 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
SE
     9 Sensor ID number
     9 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                    1 3
     9 Mounting point body ID, Mounting point node ID
SE
     9 Second mounting point body ID, Second node ID
     9 Input axis unit vector (IA) x,y,z
                                                                    0 0 1
SE
     9 Mounting point Hinge index, Axis index
     9 First focal plane unit vector (Fp1) x,y,z
     9 Second focal plane unit vector (Fp2) x,y,z
     9 Sun/Star unit vector (Us) x,y,z
     9 Velocity Aberration Option (Y/N)
     9 Euler Angle Sequence (1-6)
SE
SE
     9 CMG ID number and Gimbal number
    9 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                    10
SE 10 Sensor ID number
SE 10 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                    19
SE 10 Mounting point body ID, Mounting point node ID
SE 10 Second mounting point body ID, Second node ID
SE 10 Input axis unit vector (IA) x,y,z
SE 10 Mounting point Hinge index, Axis index
SE 10 First focal plane unit vector (Fp1) x,y,z
SE 10 Second focal plane unit vector (Fp2) x,y,z
SE 10 Sun/Star unit vector (Us) x,y,z
SE 10 Velocity Aberration Option (Y/N)
SE 10 Euler Angle Sequence (1-6)
   10 CMG ID number and Gimbal number
SE 10 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
SE 11 Sensor ID number
SE 11 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
```

| SE<br>SE<br>SE<br>SE<br>SE<br>SE<br>SE<br>SE<br>SE | 11<br>11<br>11<br>11<br>11<br>11<br>11                   | Mounting point body ID, Mounting point node ID  Second mounting point body ID, Second node ID  Input axis unit vector (IA) x,y,z  Mounting point Hinge index, Axis index  First focal plane unit vector (Fp1) x,y,z  Second focal plane unit vector (Fp2) x,y,z  Sun/Star unit vector (Us) x,y,z  Velocity Aberration Option (Y/N)  Euler Angle Sequence (1-6)  CMG ID number and Gimbal number  Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s])                                                                              | 1 9<br>3 1               |
|----------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| SEESEES SEESEES SSSSSSSSSSSSSSSSSSSSSS             | 12<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>12       | Sensor ID number  Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)  Mounting point body ID, Mounting point node ID  Second mounting point body ID, Second node ID  Input axis unit vector (IA) x,y,z  Mounting point Hinge index, Axis index  First focal plane unit vector (Fp1) x,y,z  Second focal plane unit vector (Fp2) x,y,z  Sun/Star unit vector (Us) x,y,z  Velocity Aberration Option (Y/N)  Euler Angle Sequence (1-6)  CMG ID number and Gimbal number  Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s]) | 12<br>FM<br>1 1          |
| SE SE SE SE SE SE SE SE SE                         | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13       | Sensor ID number  Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)  Mounting point body ID, Mounting point node ID  Second mounting point body ID, Second node ID  Input axis unit vector (IA) x,y,z  Mounting point Hinge index, Axis index  First focal plane unit vector (Fp1) x,y,z  Second focal plane unit vector (Fp2) x,y,z  Sun/Star unit vector (Us) x,y,z  Velocity Aberration Option (Y/N)  Euler Angle Sequence (1-6)  CMG ID number and Gimbal number  Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s]) | 13<br>FM<br>1 2          |
| SE SE SE SE SE SE SE                               | 14<br>14<br>14<br>14<br>14<br>14<br>14<br>14<br>14       | Sensor ID number  Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)  Mounting point body ID, Mounting point node ID  Second mounting point body ID, Second node ID  Input axis unit vector (IA) x,y,z  Mounting point Hinge index, Axis index  First focal plane unit vector (Fp1) x,y,z  Second focal plane unit vector (Fp2) x,y,z  Sun/Star unit vector (Us) x,y,z  Velocity Aberration Option (Y/N)  Euler Angle Sequence (1-6)  CMG ID number and Gimbal number  Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s]) | 14<br>FM<br>1 13         |
| SE SE SE SE SE SE                                  | 15<br>15<br>15<br>15<br>15<br>15<br>15<br>15<br>15<br>15 | Sensor ID number  Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)  Mounting point body ID, Mounting point node ID  Second mounting point body ID, Second node ID  Input axis unit vector (IA) x,y,z  Mounting point Hinge index, Axis index  First focal plane unit vector (Fp1) x,y,z  Second focal plane unit vector (Fp2) x,y,z  Sun/Star unit vector (Us) x,y,z  Velocity Aberration Option (Y/N)  Euler Angle Sequence (1-6)  CMG ID number and Gimbal number  Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s]) | 15<br>DN<br>1 1<br>1 0 0 |
| SE<br>SE<br>SE                                     | 16                                                       | Sensor ID number Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) Mounting point body ID, Mounting point node ID                                                                                                                                                                                                                                                                                                                                                                                                      | 16<br>MG<br>1 1          |

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SE 16 Second mounting point body ID, Second node ID
                                                                           1 0 0
SE 16 Input axis unit vector (IA) x,y,z
SE 16 Mounting point Hinge index, Axis index
SE 16 First focal plane unit vector (Fp1) x,y,z
    16 Second focal plane unit vector (Fp2) x,y,z
SE 16 Sun/Star unit vector (Us) x,y,z
SE 16 Velocity Aberration Option (Y/N)
SE 16 Euler Angle Sequence (1-6)
SE 16 CMG ID number and Gimbal number
SE 16 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                           17
    17 Sensor ID number
SE 17 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE 17 Mounting point body ID, Mounting point node ID
                                                                           1.1
SE 17 Second mounting point body ID, Second node ID SE 17 Input axis unit vector (IA) x,y,z
SE 17 Mounting point Hinge index, Axis index
SE 17 First focal plane unit vector (Fp1) x,y,z
    17 Second focal plane unit vector (Fp2) x,y,z
SE 17 Sun/Star unit vector (Us) x,y,z
SE 17 Velocity Aberration Option (Y/N)
SE 17 Euler Angle Sequence (1-6)
SE 17 CMG ID number and Gimbal number
SE 17 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                           18
SE 18 Sensor ID number
SE 18 Typ(G,R,AM,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE 18 Mounting point body ID, Mounting point node ID
                                                                           2 1
SE 18 Second mounting point body ID, Second node ID SE 18 Input axis unit vector (IA) x,y,z
SE 18 Mounting point Hinge index, Axis index
SE 18 First focal plane unit vector (Fp1) x,y,z
SE 18 Second focal plane unit vector (Fp2) x,y,z
SE 18 Sun/Star unit vector (Us) x,y,z
SE 18 Velocity Aberration Option (Y/N)
SE 18 Euler Angle Sequence (1-6)
SE 18 CMG ID number and Gimbal number
SE 18 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
                                                                           19
SE 19 Sensor ID number
SE 19 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                           AN
SE 19 Mounting point body ID, Mounting point node ID
                                                                           1 2
SE 19 Second mounting point body ID, Second node ID SE 19 Input axis unit vector (IA) x,y,z
                                                                           1 0 0
SE 19 Mounting point Hinge index, Axis index
SE 19 First focal plane unit vector (Fp1) x,y,z
    19 Second focal plane unit vector (Fp2) x,y,z
    19 Sun/Star unit vector (Us) x,y,z
   19 Velocity Aberration Option (Y/N)
   19 Euler Angle Sequence (1-6)
SE 19 CMG ID number and Gimbal number
SE 19 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
    20 Sensor ID number
    20 Typ(G,R,AM,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                           1 2
    20 Mounting point body ID, Mounting point node ID
    20 Second mounting point body ID, Second node ID
    20 Input axis unit vector (IA) x,y,z
                                                                           0 1 0
    20 Mounting point Hinge index, Axis index
   20 First focal plane unit vector (Fp1) x,y,z
20 Second focal plane unit vector (Fp2) x,y,z
    20 Sun/Star unit vector (Us) x,y,z
    20 Velocity Aberration Option (Y/N)
    20 Euler Angle Sequence (1-6)
   20 CMG ID number and Gimbal number
SE 20 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
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ACTR

AC 1 Actuator ID number

1

| AC                                                 | 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J                 |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| AC                                                 | 1 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 | 1 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 15                |
| AC                                                 | 1 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                 | 1 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 0 0             |
| AC<br>AC                                           | 1 Mounting point Hinge index, Axis index 1 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC                                                 | 1 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 | 1 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                 | 1 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 | 1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 | <pre>1 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 | 1 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 | <pre>1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
| AC                                                 | <pre>1 Initial length and rate, y(to) and ydot(to)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 1 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 1 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC                                                 | 2 Agruptor ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2                 |
| AC                                                 | <pre>2 Actuator ID number 2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J                 |
| AC                                                 | 2 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | U                 |
| AC                                                 | 2 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 6               |
| AC                                                 | 2 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                 | 2 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | -1 0 0            |
| AC                                                 | 2 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 2 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
| AC                                                 | 2 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 | <pre>2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                 | 2 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 | 2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 | 2 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC<br>AC                                           | <pre>2 Inner gimbal axis unit vector x,y,z 2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 | 2 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
| AC                                                 | 2 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 2 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                 | 3 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3                 |
| AC<br>AC                                           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3<br>J            |
| AC<br>AC                                           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J                 |
| AC<br>AC<br>AC                                     | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| AC<br>AC<br>AC<br>AC                               | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC                         | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J                 |
| AC<br>AC<br>AC<br>AC<br>AC                         | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC                         | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 5 Outer gimbal axis unit vector x,y,z 6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 5 Outer gimbal axis unit vector x,y,z 6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 8 Inner gimbal axis unit vector x,y,z</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Initial length and rate, y(to) and ydot(to)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 4 Inner gimbal axis unit vector x,y,z 5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Initial length and rate, y(to) and ydot(to) 6 Constants; K1 or wo, n or zeta, Kg, Jm</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Initial length and rate, y(to) and ydot(to)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal - angle(deg), inertia, friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 5 Inner gimbal - angle(deg), inertia, friction(D,S,B,N) 6 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 8 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm 9 Non-linearities; TLim, Tco, Dz</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J<br>17<br>100    |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal - angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal - angle(deg),inertia,friction(D,S,B,N) 4 Inner gimbal axis unit vector x,y,z 5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Initial length and rate, y(to) and ydot(to) 7 Constants; K1 or wo, n or zeta, Kg, Jm 7 Non-linearities; TLim, Tco, Dz</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 7          |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal - angle(deg), inertia, friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 5 Inner gimbal - angle(deg), inertia, friction(D,S,B,N) 6 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 8 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm 9 Non-linearities; TLim, Tco, Dz</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J 1 7 1 0 0       |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal - angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal - angle(deg),inertia,friction(D,S,B,N) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Initial length and rate, y(to) and ydot(to) 3 Constants; K1 or wo, n or zeta, Kg, Jm 3 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J 1 7 1 0 0       |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 5 Inner gimbal axis unit vector x,y,z 6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 7 Initial length and rate, y(to) and ydot(to) 8 Constants; K1 or wo, n or zeta, Kg, Jm 8 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 5 Actuator location; Node or Hinge (N or H) 6 Mounting point body ID number, node ID number 7 Second mounting point body ID, second node ID</pre>                                                                                                                                                                                                                                                                                                                                              | J<br>1 7<br>1 0 0 |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Inner gimbal- axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 4 Initial length and rate, y(to) and ydot(to) 5 Constants; K1 or wo, n or zeta, Kg, Jm 6 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 5 Actuator location; Node or Hinge (N or H) 6 Mounting point body ID number, node ID number 7 Second mounting point body ID, second node ID 8 Output axis unit vector x,y,z</pre>                                                                                                                                                                                                                                                                                                             | J 1 7 1 0 0       |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Inner gimbal- axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Initial length and rate, y(to) and ydot(to) 3 Constants; K1 or wo, n or zeta, Kg, Jm 3 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 4 Actuator location; Node or Hinge (N or H) 4 Mounting point body ID number, node ID number 4 Second mounting point body ID, second node ID 4 Output axis unit vector x,y,z 4 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                               | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 6 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 7 Initial length and rate, y(to) and ydot(to) 7 Constants; K1 or wo, n or zeta, Kg, Jm 7 Non-linearities; TLim, Tco, Dz 8 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Second mounting point body ID, second node ID 9 Output axis unit vector x,y,z 9 Mounting point Hinge index, Axis index 9 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                            | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal angle(deg), inertia, friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Initial length and rate, y(to) and ydot(to) 3 Constants; K1 or wo, n or zeta, Kg, Jm 3 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 4 Actuator location; Node or Hinge (N or H) 4 Mounting point body ID number, node ID number 4 Second mounting point body ID, second node ID 4 Output axis unit vector x,y,z 4 Mounting point Hinge index, Axis index 4 Rotor spin axis unit vector x,y,z 5 Initial rotor momentum, H                                                                                                                                                                          | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 4 Inner gimbal axis unit vector x,y,z 5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Initial length and rate, y(to) and ydot(to) 7 Constants; K1 or wo, n or zeta, Kg, Jm 7 Non-linearities; TLim, Tco, Dz 8 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Second mounting point body ID, second node ID 9 Output axis unit vector x,y,z 9 Mounting point Hinge index, Axis index 9 Rotor spin axis unit vector x,y,z 9 Initial rotor momentum, H 9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                           | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 4 Outer gimbal axis unit vector x,y,z 5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 8 Inner gimbal axis unit vector x,y,z 9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 9 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm 9 Non-linearities; TLim, Tco, Dz 9 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Cutput axis unit vector x,y,z 9 Mounting point Hinge index, Axis index 9 Rotor spin axis unit vector x,y,z 9 Initial rotor momentum, H 9 Outer gimbal axis unit vector x,y,z                                                                                                        | J<br>1 7<br>1 0 0 |
| AC A           | <pre>3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Outer gimbal axis unit vector x,y,z 3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 3 Inner gimbal axis unit vector x,y,z 3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 4 Initial length and rate, y(to) and ydot(to) 5 Constants; K1 or wo, n or zeta, Kg, Jm 6 Non-linearities; TLim, Tco, Dz 4 Actuator ID number 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 4 Actuator location; Node or Hinge (N or H) 4 Mounting point body ID number, node ID number 4 Second mounting point body ID, second node ID 6 Output axis unit vector x,y,z 6 Mounting point Hinge index, Axis index 7 Rotor spin axis unit vector x,y,z 8 Initial rotor momentum, H 8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 9 Outer gimbal axis unit vector x,y,z 9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                     | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 4 Outer gimbal axis unit vector x,y,z 5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 8 Inner gimbal axis unit vector x,y,z 9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 9 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm 9 Non-linearities; TLim, Tco, Dz 9 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Cutput axis unit vector x,y,z 9 Mounting point Hinge index, Axis index 9 Rotor spin axis unit vector x,y,z 9 Initial rotor momentum, H 9 Outer gimbal axis unit vector x,y,z                                                                                                        | J<br>1 7<br>1 0 0 |
| AC A           | 3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 3 Actuator location; Node or Hinge (N or H) 3 Mounting point body ID number, node ID number 3 Second mounting point body ID, second node ID 3 Output axis unit vector x,y,z 3 Mounting point Hinge index, Axis index 3 Rotor spin axis unit vector x,y,z 3 Initial rotor momentum, H 5 Outer gimbal - angle(deg), inertia, friction(D,S,B,N) 6 Outer gimbal axis unit vector x,y,z 7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 8 Inner gimbal - angle(deg), inertia, friction(D,S,B,N) 9 Inner gimbal axis unit vector x,y,z 9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 9 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm 9 Non-linearities; TLim, Tco, Dz 9 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Second mounting point body ID, second node ID 9 Output axis unit vector x,y,z 9 Mounting point Hinge index, Axis index 9 Rotor spin axis unit vector x,y,z 9 Initial rotor momentum, H 9 Outer gimbal angle(deg), inertia, friction(D,S,B,N) 9 Outer gimbal axis unit vector x,y,z 9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 9 Inner gimbal - angle(deg), inertia, friction(D,S,B,N) | J<br>1 7<br>1 0 0 |

| AC       | 4 | Initial length and rate, y(to) and ydot(to)                                                   |        |
|----------|---|-----------------------------------------------------------------------------------------------|--------|
| AC       |   | Constants; K1 or wo, n or zeta, Kg, Jm                                                        |        |
| AC       | 4 | Non-linearities; TLim, Tco, Dz                                                                |        |
|          |   |                                                                                               |        |
| AC       | 5 | Actuator ID number                                                                            | 5      |
| AC       |   | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                           | J      |
| AC       |   | Actuator location; Node or Hinge (N or H)                                                     |        |
| AC       | 5 | Mounting point body ID number, node ID number                                                 | 1 8    |
| AC       |   | Second mounting point body ID, second node ID                                                 | 0 1 0  |
| AC       |   | Output axis unit vector x,y,z                                                                 | 0 1 0  |
| AC       |   | Mounting point Hinge index, Axis index                                                        |        |
| AC       |   | Rotor spin axis unit vector x,y,z                                                             |        |
| AC       | - | Initial rotor momentum, H                                                                     |        |
| AC<br>AC |   | Outer gimbal- angle(deg), inertia, friction(D, S, B, N) Outer gimbal axis unit vector x, y, z |        |
| AC       |   | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                            |        |
| AC       |   | Inner gimbal - angle (deg), inertia, friction (D, S, B, N)                                    |        |
| AC       |   | Inner gimbal axis unit vector x,y,z                                                           |        |
| AC       |   | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                 |        |
| AC       |   | Initial length and rate, y(to) and ydot(to)                                                   |        |
| AC       |   | Constants; K1 or wo, n or zeta, Kg, Jm                                                        |        |
| AC       |   | Non-linearities; TLim, Tco, Dz                                                                |        |
|          |   |                                                                                               |        |
| AC       | 6 | Actuator ID number                                                                            | 6      |
| AC       | 6 | Type $(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)$                                                        | J      |
| AC       |   | Actuator location; Node or Hinge (N or H)                                                     |        |
| AC       |   | Mounting point body ID number, node ID number                                                 | 1 8    |
| AC       |   | Second mounting point body ID, second node ID                                                 |        |
| AC       |   | Output axis unit vector x,y,z                                                                 | 0 -1 0 |
| AC       |   | Mounting point Hinge index, Axis index                                                        |        |
| AC       |   | Rotor spin axis unit vector x,y,z                                                             |        |
| AC<br>AC |   | Initial rotor momentum, H  Outer girbal angle/deg) inertia friction(D S B N)                  |        |
| AC       |   | Outer gimbal- angle(deg), inertia, friction(D, S, B, N) Outer gimbal axis unit vector x, y, z |        |
| AC       |   | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                            |        |
| AC       |   | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                       |        |
| AC       |   | Inner gimbal axis unit vector x,y,z                                                           |        |
| AC       |   | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                             |        |
| AC       |   | Initial length and rate, y(to) and ydot(to)                                                   |        |
| AC       |   | Constants; K1 or wo, n or zeta, Kg, Jm                                                        |        |
| AC       | 6 | Non-linearities; TLim, Tco, Dz                                                                |        |
|          |   |                                                                                               |        |
| AC       | 7 | Actuator ID number                                                                            | 7      |
| AC       |   | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                           | J      |
| AC       |   | Actuator location; Node or Hinge (N or H)                                                     |        |
| AC       |   | Mounting point body ID number, node ID number                                                 | 1 5    |
| AC       |   | Second mounting point body ID, second node ID                                                 | 0 1 0  |
| AC<br>AC |   | Output axis unit vector x,y,z Mounting point Hinge index, Axis index                          | 010    |
| AC       |   | Rotor spin axis unit vector x,y,z                                                             |        |
| AC       |   | Initial rotor momentum, H                                                                     |        |
| AC       |   | Outer gimbal- angle (deg), inertia, friction (D, S, B, N)                                     |        |
| AC       |   | Outer gimbal axis unit vector x,y,z                                                           |        |
| AC       |   | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                |        |
| AC       | 7 | <pre>Inner gimbal- angle(deg), inertia, friction(D,S,B,N)</pre>                               |        |
| AC       | 7 | Inner gimbal axis unit vector x,y,z                                                           |        |
| AC       |   | <pre>In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                  |        |
| AC       |   | Initial length and rate, y(to) and ydot(to)                                                   |        |
| AC       |   | Constants; K1 or wo, n or zeta, Kg, Jm                                                        |        |
| AC       | 7 | Non-linearities; TLim, Tco, Dz                                                                |        |
|          | _ |                                                                                               | ^      |
| AC       |   | Actuator ID number                                                                            | 8      |
| AC       |   | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                           | J      |
| AC       |   | Actuator location; Node or Hinge (N or H)                                                     | 1 =    |
| AC       |   | Mounting point body ID number, node ID number                                                 | 1 5    |
| AC       |   | Second mounting point body ID, second node ID                                                 | 0 -1 0 |
| AC<br>AC |   | Output axis unit vector x,y,z Mounting point Hinge index, Axis index                          | 0 -1 0 |
| AC<br>AC |   | Rotor spin axis unit vector x,y,z                                                             |        |
| AC       |   | Initial rotor momentum, H                                                                     |        |
| AC       |   | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                       |        |
| -20      |   | case grames digesters, the case the control of D. D. D.                                       |        |

Contract No.: NAS8-00114 8 Outer gimbal axis unit vector x,y,z 8 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) 8 Inner gimbal- angle(deg), inertia, friction(D, S, B, N) 8 Inner gimbal axis unit vector x,y,z AC 8 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC AC 8 Initial length and rate, y(to) and ydot(to) 8 Constants; K1 or wo, n or zeta, Kg, Jm 8 Non-linearities; TLim, Tco, Dz 9 Actuator ID number AC AC 9 Type (J, H, MO, T, B, MA, SG, DG, W, L, M1-M7) 9 Actuator location; Node or Hinge (N or H) AC 1 7 9 Mounting point body ID number, node ID number AC 9 Second mounting point body ID, second node ID AC 0 1 0 9 Output axis unit vector x,y,z АÇ 9 Mounting point Hinge index, Axis index AC 9 Rotor spin axis unit vector x,y,z AC 9 Initial rotor momentum, H AC 9 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 9 Outer gimbal axis unit vector x,y,z AC 9 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 9 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) AC 9 Inner gimbal axis unit vector x,y,z 9 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 9 Initial length and rate, y(to) and ydot(to) 9 Constants; K1 or wo, n or zeta, Kg, Jm AC 9 Non-linearities; TLim, Tco, Dz AC 10 AC 10 Actuator ID number 10 Type (J, H, MO, T, B, MA, SG, DG, W, L, M1-M7) J AC 10 Actuator location; Node or Hinge (N or H) 1 7 AC 10 Mounting point body ID number, node ID number AC 10 Second mounting point body ID, second node ID AC 10 Output axis unit vector x,y,z 0 -1 0 AC 10 Mounting point Hinge index, Axis index AC 10 Rotor spin axis unit vector x,y,z 10 Initial rotor momentum, H AC 10 Outer gimbal- angle(deg), inertia, friction(D, S, B, N) AC 10 Outer gimbal axis unit vector x,y,z AC 10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC 10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) AC 10 Inner gimbal axis unit vector x,y,z AC 10 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 10 Initial length and rate, y(to) and ydot(to) AC 10 Constants; K1 or wo, n or zeta, Kg, Jm AC 10 Non-linearities; TLim, Tco, Dz AC 11 Actuator ID number 11 AC 11 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) AC 11 Actuator location, Node or name in or m, AC 11 Mounting point body ID number, node ID number 1 6 AC 11 Second mounting point body ID, second node ID AC 11 Output axis unit vector x,y,z 0 1 0 11 Mounting point Hinge index, Axis index AC 11 Rotor spin axis unit vector x,y,z AC 11 Initial rotor momentum, H 11 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) AC 11 Outer gimbal axis unit vector x,y,z AC 11 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 11 Inner gimbal- angle(deg), inertia, friction(D, S, B, N) AC 11 Inner gimbal axis unit vector x,y,z AC 11 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 11 Initial length and rate, y(to) and ydot(to) 11 Constants; K1 or wo, n or zeta, Kg, Jm AC 11 Non-linearities; TLim, Tco, Dz AC 12 Actuator ID number AC 12 Type(J,H,MO,T,B,MA, 12 12 Type (J, H, MO, T, B, MA, SG, DG, W, L, M1-M7) AC 12 Actuator location; Node or Hinge (N or H)

AC 12 Mounting point body ID number, node ID number AC 12 Second mounting point body ID, second node ID

Date: 14 February 2003

1 6

| AC                                                                              | 12 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 -1 0            |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| AC                                                                              | 12 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                              | 12 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                                              | 12 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                                              | 12 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC                                                                              | 12 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                              | 12 Out gim fric (Tfi, Tgfo, GAM)/(Tfi, M, D, Kf)/(m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                                              | 12 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC                                                                              | 12 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                              | 12 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                                              | 12 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
| AC                                                                              | 12 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                              | 12 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
| 3.0                                                                             | 12 Actuation TD mushous                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13                |
| AC                                                                              | 13 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J                 |
| AC                                                                              | 13 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J                 |
| AC                                                                              | 13 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                                              | 13 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 7               |
| AC                                                                              | 13 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |
| AC                                                                              | 13 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 0 1             |
| AC                                                                              | 13 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                              | 13 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
| AC                                                                              | 13 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                                              | 13 Outer gimbal - angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                                              | 13 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                              | 13 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
| AC                                                                              | <pre>13 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |
| AC                                                                              | 13 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                              | 13 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |
| AC                                                                              | 13 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
|                                                                                 | <del>-</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                                              | 13 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                              | 13 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
| AC                                                                              | 14 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 14                |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | J                 |
| AC                                                                              | 14 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J                 |
| AC                                                                              | 14 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                                              | 14 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 5               |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1 5               |
| AC                                                                              | 14 Mounting point body ID number, node ID number<br>14 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 5<br>0 0 -1     |
| AC<br>AC<br>AC                                                                  | 14 Mounting point body ID number, node ID number<br>14 Second mounting point body ID, second node ID<br>14 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| AC<br>AC<br>AC<br>AC                                                            | 14 Mounting point body ID number, node ID number<br>14 Second mounting point body ID, second node ID<br>14 Output axis unit vector x,y,z<br>14 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
| AC<br>AC<br>AC<br>AC                                                            | 14 Mounting point body ID number, node ID number<br>14 Second mounting point body ID, second node ID<br>14 Output axis unit vector x,y,z<br>14 Mounting point Hinge index, Axis index<br>14 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC<br>AC<br>AC<br>AC<br>AC                                                      | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                    | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Inner gimbal axis unit vector x,y,z 14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 15 Inner gimbal axis unit vector x,y,z 16 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 17 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 18 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
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| AC A                                        | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal - angle(deg), inertia, friction(D,S,B,N) 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Inner gimbal - angle(deg), inertia, friction(D,S,B,N) 14 Inner gimbal axis unit vector x,y,z 14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Initial length and rate, y(to) and ydot(to) 14 Constants; K1 or wo, n or zeta, Kg, Jm 14 Non-linearities; TLim, Tco, Dz 15 Actuator ID number 15 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 15 Actuator location; Node or Hinge (N or H) 15 Mounting point body ID number, node ID number 15 Second mounting point body ID, second node ID 15 Output axis unit vector x,y,z 15 Mounting point Hinge index, Axis index 15 Rotor spin axis unit vector x,y,z 15 Initial rotor momentum, H 15 Outer gimbal angle(deg), inertia, friction(D,S,B,N) 15 Outer gimbal axis unit vector x,y,z 15 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 15 Inner gimbal angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                       | 15<br>J           |
| AC A                                        | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 15 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 16 Inner gimbal axis unit vector x,y,z 17 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 18 Initial length and rate, y(to) and ydot(to) 19 Constants; K1 or wo, n or zeta, Kg, Jm 19 Non-linearities; TLim, Tco, Dz 19 Actuator ID number 19 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 10 Actuator location; Node or Hinge (N or H) 10 Mounting point body ID number, node ID number 10 Second mounting point body ID, second node ID 10 Output axis unit vector x,y,z 11 Initial rotor momentum, H 12 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 13 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Inner gimbal axis unit vector x,y,z 15 Inner gimbal axis unit vector x,y,z                                                                                         | 15<br>J           |
| AC A                                        | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) 14 Inner gimbal axis unit vector x,y,z 14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) 14 Initial length axis unit vector x,y,z 14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) 14 Initial length and rate, y(to) and ydot(to) 14 Constants; K1 or wo, n or zeta, Kg, Jm 14 Non-linearities; TLim, Tco, Dz 15 Actuator ID number 15 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 15 Actuator location; Node or Hinge (N or H) 15 Mounting point body ID number, node ID number 15 Second mounting point body ID, second node ID 15 Output axis unit vector x,y,z 15 Initial rotor momentum, H 15 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 15 Outer gimbal axis unit vector x,y,z 15 Inner gimbal axis unit vector x,y,z 15 Inner gimbal axis unit vector x,y,z 15 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) 15 Inner gimbal axis unit vector x,y,z 15 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) 15 Inner gimbal axis unit vector x,y,z | 15<br>J           |
| AC A                                        | 14 Mounting point body ID number, node ID number 14 Second mounting point body ID, second node ID 14 Output axis unit vector x,y,z 14 Mounting point Hinge index, Axis index 14 Rotor spin axis unit vector x,y,z 14 Initial rotor momentum, H 14 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Outer gimbal axis unit vector x,y,z 14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 14 Inner gimbal axis unit vector x,y,z 14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 14 Initial length and rate, y(to) and ydot(to) 14 Constants; K1 or wo, n or zeta, Kg, Jm 14 Non-linearities; TLim, Tco, Dz 15 Actuator ID number 15 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 15 Actuator location; Node or Hinge (N or H) 15 Mounting point body ID number, node ID number 15 Second mounting point body ID, second node ID 15 Output axis unit vector x,y,z 15 Mounting point Hinge index, Axis index 15 Rotor spin axis unit vector x,y,z 15 Initial rotor momentum, H 15 Outer gimbal axis unit vector x,y,z 15 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 15 Inner gimbal axis unit vector x,y,z 15 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                    | 15<br>J           |

| AC                                                 |                                                                                                                                              | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 16                |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| AC                                                 |                                                                                                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J                 |
| AC                                                 |                                                                                                                                              | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 | : 16                                                                                                                                         | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 16                |
| AC                                                 | : 16                                                                                                                                         | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                 | : 16                                                                                                                                         | Output axis unit vector x, y, z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0 0 -1            |
| AC                                                 |                                                                                                                                              | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 |                                                                                                                                              | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
| AC                                                 |                                                                                                                                              | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 |                                                                                                                                              | Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
|                                                    |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| AC                                                 |                                                                                                                                              | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 |                                                                                                                                              | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 |                                                                                                                                              | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |
| AC                                                 |                                                                                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 | : 16                                                                                                                                         | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
| AC                                                 | 16                                                                                                                                           | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
| AC                                                 | 16                                                                                                                                           | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 16                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
|                                                    |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| AC                                                 | 17                                                                                                                                           | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 17                |
| AC                                                 |                                                                                                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ĵ                 |
| AC                                                 |                                                                                                                                              | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | •                 |
| AC                                                 |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1 2               |
|                                                    |                                                                                                                                              | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 2               |
| AC                                                 |                                                                                                                                              | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 0 0             |
| AC                                                 |                                                                                                                                              | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 0 0             |
| AC                                                 |                                                                                                                                              | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC                                                 | 17                                                                                                                                           | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
| AC                                                 | 17                                                                                                                                           | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                 | 17                                                                                                                                           | Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                 | 17                                                                                                                                           | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 | 17                                                                                                                                           | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 |                                                                                                                                              | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                 |                                                                                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                 |                                                                                                                                              | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
| AC                                                 |                                                                                                                                              | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
| AC                                                 |                                                                                                                                              | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
|                                                    |                                                                                                                                              | Constants; ki of wo, ii of zeta, kg, om                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |
|                                                    |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| AC                                                 |                                                                                                                                              | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC                                                 | 17                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1.0               |
| AC<br>AC                                           | 17<br>18                                                                                                                                     | Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 18                |
| AC<br>AC<br>AC                                     | 17<br>18<br>18                                                                                                                               | Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 18<br>J           |
| AC<br>AC                                           | 17<br>18<br>18<br>18                                                                                                                         | Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J                 |
| AC<br>AC<br>AC                                     | 17<br>18<br>18<br>18                                                                                                                         | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC<br>AC<br>AC<br>AC                               | 17<br>18<br>18<br>18                                                                                                                         | Non-linearities; TLim, Tco, Dz  Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)  Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J<br>1 2          |
| AC<br>AC<br>AC<br>AC                               | 17<br>18<br>18<br>18<br>18                                                                                                                   | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J                 |
| AC<br>AC<br>AC<br>AC<br>AC                         | 17<br>18<br>18<br>18<br>18<br>18                                                                                                             | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 17<br>18<br>18<br>18<br>18<br>18<br>18                                                                                                       | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J<br>1 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 17<br>18<br>18<br>18<br>18<br>18<br>18                                                                                                       | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J<br>1 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                                                 | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | J<br>1 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                                           | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J<br>1 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                                           | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                                     | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                                     | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                               | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                         | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                                         | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                             | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                             | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 2          |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                             | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18                                                             | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19                                                 | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19                                                 | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19                                                 | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19                                                       | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19                                                 | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                         | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19                                           | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                 | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19                                     | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                          | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19                               | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                        | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19                   | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                          | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19                         | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                        | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19                   | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                       | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19 | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                  | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19 | Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) | J<br>1 2<br>0 1 0 |
| AC A           | 17<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>18<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19<br>19 | Actuator ID number  Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                  | J<br>1 2<br>0 1 0 |

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| AC                                                                   | 22                                                                                     | Outon minhal anala/dan) inantia frintian/D C D NI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| AC                                                                   |                                                                                        | Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   |                                                                                        | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
| AC                                                                   |                                                                                        | Inner gimbal- angle (deg), inertia, friction (D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                   |                                                                                        | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC                                                                   |                                                                                        | <pre>In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |
| AC                                                                   |                                                                                        | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                                   | 23                                                                                     | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   | 23                                                                                     | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
| 3.0                                                                  | 24                                                                                     | Jahrahan 70 memban                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 24                |
| AC<br>AC                                                             |                                                                                        | Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MA                |
| AC                                                                   |                                                                                        | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 121               |
| AC                                                                   |                                                                                        | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 2               |
| AC                                                                   | 24                                                                                     | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                                   |                                                                                        | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 1 0             |
| AC                                                                   | 24                                                                                     | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   | 24                                                                                     | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
| AC                                                                   |                                                                                        | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                   |                                                                                        | Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
| AC                                                                   |                                                                                        | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC<br>AC                                                             |                                                                                        | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
| AC                                                                   |                                                                                        | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC                                                                   |                                                                                        | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                                   |                                                                                        | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                                   | 24                                                                                     | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   | 24                                                                                     | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
|                                                                      | ٥-                                                                                     | • · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ٥٣                |
| AC                                                                   |                                                                                        | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 25<br>M3          |
| AC<br>AC                                                             |                                                                                        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MA                |
| AC                                                                   |                                                                                        | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 2               |
| AC                                                                   |                                                                                        | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
| AC                                                                   |                                                                                        | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 0 1             |
| AC                                                                   |                                                                                        | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   |                                                                                        | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
| AC                                                                   |                                                                                        | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                   |                                                                                        | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
| AC                                                                   |                                                                                        | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC<br>AC                                                             |                                                                                        | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
| AC                                                                   |                                                                                        | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
| AC                                                                   |                                                                                        | In gim fric (Tfi, Tgfo, GAM)/(Tfi, M, D, Kf)/(m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |
| AC                                                                   |                                                                                        | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |
| AC                                                                   | 25                                                                                     | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
| AC                                                                   | 25                                                                                     | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |
|                                                                      |                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| NC.                                                                  | 26                                                                                     | Actuator TD number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 26                |
| AC<br>AC                                                             |                                                                                        | Actuator ID number Type(J.H.MO.T.B.MA.SG.DG.W.L.M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 26<br>J           |
| AC                                                                   | 26                                                                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 26<br>J           |
|                                                                      | 26<br>26                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
| AC<br>AC                                                             | 26<br>26<br>26                                                                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | J                 |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 26<br>26<br>26<br>26<br>26                                                             | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J                 |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 26<br>26<br>26<br>26<br>26<br>26                                                       | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                     | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                                           | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                                           | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                              | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                           | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                         | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                               | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                     | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                           | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26                   | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                             | J<br>3 2          |
| AC                               | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                           | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                               | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm                                                                                        | J<br>3 2          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC       | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                               | J<br>3 2          |
| AC A                             | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                         | J<br>3 2<br>1 0 0 |
| AC A                             | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                      | J<br>3 2          |
| AC A                             | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>2        | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                         | J 3 2 1 0 0       |
| AC A                             | 26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>26<br>27<br>27<br>27 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) | J 3 2 1 0 0       |

| AC                                                                   |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
|                                                                      | 27                                                                                                                                           | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |
| AC                                                                   |                                                                                                                                              | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 1 0                    |
| AC                                                                   |                                                                                                                                              | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |
| AC                                                                   |                                                                                                                                              | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| AC                                                                   |                                                                                                                                              | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                          |
| AC                                                                   |                                                                                                                                              | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |
| AC                                                                   |                                                                                                                                              | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |
|                                                                      |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| AC                                                                   |                                                                                                                                              | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                          |
| AC                                                                   |                                                                                                                                              | Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                          |
| AC                                                                   |                                                                                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |
| AC                                                                   |                                                                                                                                              | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |
| AC                                                                   |                                                                                                                                              | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |
| AC                                                                   |                                                                                                                                              | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |
| AC                                                                   | 27                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                          |
|                                                                      |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| AC                                                                   | 28                                                                                                                                           | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 28                       |
| AC                                                                   |                                                                                                                                              | Type $(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J                        |
| AC                                                                   |                                                                                                                                              | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                          |
| AC                                                                   | 28                                                                                                                                           | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3 2                      |
| AC                                                                   | 28                                                                                                                                           | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |
| AC                                                                   | 28                                                                                                                                           | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 0 1                    |
| AC                                                                   | 28                                                                                                                                           | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |
| AC                                                                   |                                                                                                                                              | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| AC                                                                   |                                                                                                                                              | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                          |
| AC                                                                   |                                                                                                                                              | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |
| AC                                                                   |                                                                                                                                              | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |
| AC                                                                   |                                                                                                                                              | Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                          |
| AC                                                                   |                                                                                                                                              | Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |
|                                                                      |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| AC                                                                   |                                                                                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |
| AC                                                                   |                                                                                                                                              | In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| AC                                                                   |                                                                                                                                              | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |
| AC                                                                   |                                                                                                                                              | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |
| AC                                                                   | 28                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                          |
|                                                                      |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0.0                      |
| AC                                                                   |                                                                                                                                              | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 29                       |
| AC                                                                   | 29                                                                                                                                           | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MO                       |
| AC                                                                   |                                                                                                                                              | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                          |
|                                                                      |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| AC                                                                   | 29                                                                                                                                           | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1 2                      |
| AC<br>AC                                                             |                                                                                                                                              | Mounting point body ID number, node ID number<br>Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1 2                      |
|                                                                      | 29                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1 2<br>1 0 0             |
| AC                                                                   | 29<br>29                                                                                                                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |
| AC<br>AC<br>AC                                                       | 29<br>29<br>29                                                                                                                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                          |
| AC<br>AC<br>AC                                                       | 29<br>29<br>29<br>29                                                                                                                         | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                          |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 29<br>29<br>29<br>29<br>29                                                                                                                   | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                          |
| AC<br>AC<br>AC<br>AC<br>AC                                           | 29<br>29<br>29<br>29<br>29<br>29                                                                                                             | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                     | 29<br>29<br>29<br>29<br>29<br>29                                                                                                             | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                                       | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                                 | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                         | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                           | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                           | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
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| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 0 0                    |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29                                                                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 0 0                    |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30                                                                   | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 0 0                    |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30                                                             | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 0 0<br>30<br>MO        |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30                                                             | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 0 0                    |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30                                                             | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30                                                       | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; Kl or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 0 0<br>30<br>MO        |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30                                                       | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1 0 0<br>30<br>MO<br>1 2 |
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| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30                                           | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                 | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                                     | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                              | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                           | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                              | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                  | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30                               | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                  | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30 | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                      | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30 | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal- axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                  | 1 0 0<br>30<br>MO<br>1 2 |
| AC A                             | 29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>29<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30       | Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg), inertia, friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Innitial length and rate, y(to) and ydot(to) | 1 0 0<br>30<br>MO<br>1 2 |

#### CONTROLLER

| CO<br>CO<br>CO<br>CO                     | 1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1<br>UD<br>0.10<br>21 16                                                                                        |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| C0<br>C0                                 | <pre>2 Controller ID number 2 Controller type (CB,CM,DB,DM,UC,UD) 2 Sample time (sec)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2<br>UC                                                                                                         |
| CO<br>CO                                 | 2 Number of inputs, Number of outputs 2 Number of states 2 Output No., Input type (I,S,T), Input ID, Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 6,6<br>0                                                                                                        |
| C0<br>C0                                 | 3 Controller ID number 3 Controller type (CB,CM,DB,DM,UC,UD) 3 Sample time (sec)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3<br>CB                                                                                                         |
| CO<br>CO                                 | 3 Number of inputs, Number of outputs 3 Number of states                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2 2                                                                                                             |
| CO                                       | 3 Output No., Input type (I,S,T), Input ID, Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1 T 1 1                                                                                                         |
| CO                                       | 3 Output No., Input type (I,S,T), Input ID, Gain TRANSFER FUN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2 T 2 1                                                                                                         |
| TR T | 1 Transfer function ID number 1 Controller ID number 1 Input type (I,S or T), Input ID number 1 Order of numerator 1 Numerator coefficients (4 per line max) 1 Order of denominator 1 Denominator coefficients (4 per line max) 1 Transfer function gain  2 Transfer function ID number 2 Controller ID number 2 Input type (I,S or T), Input ID number 2 Order of numerator | 1<br>3<br>1 1<br>12<br>0 0 0 0 0<br>0 0 0 0<br>0 0 0 0<br>0 .9794<br>14<br>0 0 0 0 0<br>0 0 0 0<br>0 0 0 0<br>1 |
| TR                                       | 2 Numerator coefficients (4 per line max)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0 0 0 0                                                                                                         |
| TR<br>TR                                 | 2 Numerator coefficients (4 per line max) 2 Numerator coefficients (4 per line max)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0000                                                                                                            |
| TR<br>TR                                 | 2 Numerator coefficients (4 per line max) 2 Order of denominator                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0<br>14                                                                                                         |
| TR                                       | 2 Denominator coefficients (4 per line max)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0 0 0 0                                                                                                         |
| TR<br>TR                                 | 2 Denominator coefficients (4 per line max) 2 Denominator coefficients (4 per line max)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0000                                                                                                            |
| TR                                       | 2 Denominator coefficients (4 per line max)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0 0 0                                                                                                           |
| TR                                       | 2 Transfer function gain INTERCONNECT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1                                                                                                               |
| IN                                       | 1 Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                                                                                                               |
| IN<br>IN                                 | 1 Source type(S,C, or F), Source ID, Source row # 1 Destination type(A or C), Dest ID, Dest row #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | C 1 1<br>A 1 1                                                                                                  |
| IN                                       | 1 Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1                                                                                                               |
| IN                                       | 2 Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2                                                                                                               |
| IN<br>IN                                 | <pre>2 Source type(S,C, or F),Source ID,Source row # 2 Destination type(A or C),Dest ID,Dest row #</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | C 1 2<br>A 2 1                                                                                                  |
| IN                                       | 2 Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1                                                                                                               |

| IN                                       | 3                                                                                                                                                                                                              | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          | 3                                                                                                                                                                               |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IN                                       | 3                                                                                                                                                                                                              | Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ID, Source row                                                                                                                                                                   | #        | C 1 3                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ID,Dest row #                                                                                                                                                                    |          | A 3 1                                                                                                                                                                           |
| IN                                       | 3                                                                                                                                                                                                              | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |          | 1                                                                                                                                                                               |
| T37                                      |                                                                                                                                                                                                                | Tutanana TD number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                  |          | 4                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Interconnect ID number Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ID Source row                                                                                                                                                                    | #        | C 1 4                                                                                                                                                                           |
| IN<br>IN                                 |                                                                                                                                                                                                                | Destination type(A or C), Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                  | π        | A 4 1                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ID, Desc IOW #                                                                                                                                                                   |          | 1                                                                                                                                                                               |
| 211                                      | •                                                                                                                                                                                                              | 00.222                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          |                                                                                                                                                                                 |
| IN                                       | 5                                                                                                                                                                                                              | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          | 5                                                                                                                                                                               |
| IN                                       | 5                                                                                                                                                                                                              | Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ID, Source row                                                                                                                                                                   | #        | C 1 5                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Destination type(A or C), Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ID,Dest row #                                                                                                                                                                    |          | A 5 1                                                                                                                                                                           |
| IN                                       | 5                                                                                                                                                                                                              | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |          | 1                                                                                                                                                                               |
| IN                                       | 6                                                                                                                                                                                                              | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          | 6                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Source type(S,C, or F), Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | TD Source row                                                                                                                                                                    | #        | C 1 6                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Destination type(A or C), Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                  | a .      | A 6 1                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ·                                                                                                                                                                                |          | 1                                                                                                                                                                               |
|                                          |                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                  |          | _                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  | и        | 7                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Source type(S,C, or F), Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                  | #        | C 1 7<br>A 7 1                                                                                                                                                                  |
| IN<br>IN                                 |                                                                                                                                                                                                                | Destination type(A or C), Dest Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ID, Dest IOW #                                                                                                                                                                   |          | 1                                                                                                                                                                               |
| TIM                                      | ,                                                                                                                                                                                                              | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |          | •                                                                                                                                                                               |
| IN                                       | 8                                                                                                                                                                                                              | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          | 8                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ID, Source row                                                                                                                                                                   | #        | C 1 8                                                                                                                                                                           |
| IN                                       | 8                                                                                                                                                                                                              | Destination type(A or C), Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ID,Dest row #                                                                                                                                                                    |          | A 8 1                                                                                                                                                                           |
| IN                                       | 8                                                                                                                                                                                                              | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |          | 1                                                                                                                                                                               |
|                                          | _                                                                                                                                                                                                              | * h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                  |          | 9                                                                                                                                                                               |
| IN                                       |                                                                                                                                                                                                                | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | TD Courae row                                                                                                                                                                    | #        | C 1 9                                                                                                                                                                           |
| IN<br>IN                                 |                                                                                                                                                                                                                | Source type(S,C, or F),Source<br>Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                  | π        | A 9 1                                                                                                                                                                           |
| IN                                       |                                                                                                                                                                                                                | Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 22,2000 20                                                                                                                                                                       |          | 1                                                                                                                                                                               |
|                                          |                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                  |          |                                                                                                                                                                                 |
|                                          |                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                  |          |                                                                                                                                                                                 |
| IN                                       |                                                                                                                                                                                                                | Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                  |          | 10                                                                                                                                                                              |
| IN                                       | 10                                                                                                                                                                                                             | Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                  | #        | C 1 10                                                                                                                                                                          |
| IN<br>IN                                 | 10<br>10                                                                                                                                                                                                       | Source type(S,C, or F),Source Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                  | #        | C 1 10<br>A 10 1                                                                                                                                                                |
| IN                                       | 10<br>10                                                                                                                                                                                                       | Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                  | #        | C 1 10                                                                                                                                                                          |
| IN<br>IN                                 | 10<br>10<br>10                                                                                                                                                                                                 | Source type(S,C, or F),Source Destination type(A or C),Dest Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                  | #        | C 1 10<br>A 10 1                                                                                                                                                                |
| IN<br>IN                                 | 10<br>10<br>10                                                                                                                                                                                                 | Source type(S,C, or F),Source Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ID,Dest row #                                                                                                                                                                    |          | C 1 10<br>A 10 1                                                                                                                                                                |
| IN<br>IN<br>IN                           | 10<br>10<br>10<br>11<br>11<br>11                                                                                                                                                                               | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain<br>Interconnect ID number<br>Source type(S,C, or F),Source<br>Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ID,Dest row # ID,Source row                                                                                                                                                      |          | C 1 10<br>A 10 1<br>1<br>C 1 11<br>A 11 1                                                                                                                                       |
| IN<br>IN<br>IN<br>IN                     | 10<br>10<br>10<br>11<br>11<br>11                                                                                                                                                                               | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain<br>Interconnect ID number<br>Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ID,Dest row # ID,Source row                                                                                                                                                      |          | C 1 10<br>A 10 1<br>1<br>C 1 11                                                                                                                                                 |
| IN<br>IN<br>IN<br>IN<br>IN               | 10<br>10<br>10<br>11<br>11<br>11                                                                                                                                                                               | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain<br>Interconnect ID number<br>Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ID,Dest row # ID,Source row                                                                                                                                                      |          | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1                                                                                                                                 |
| IN<br>IN<br>IN<br>IN<br>IN<br>IN         | 10<br>10<br>10<br>11<br>11<br>11<br>11                                                                                                                                                                         | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest<br>Gain Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ID,Dest row # ID,Source row # ID,Dest row #                                                                                                                                      | #        | C 1 10<br>A 10 1<br>1<br>C 1 11<br>A 11 1                                                                                                                                       |
| IN<br>IN<br>IN<br>IN<br>IN               | 10<br>10<br>10<br>11<br>11<br>11<br>11<br>12<br>12                                                                                                                                                             | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain<br>Interconnect ID number<br>Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                                                                                    | #        | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1                                                                                                                                 |
| IN            | 10<br>10<br>10<br>11<br>11<br>11<br>11<br>12<br>12<br>12                                                                                                                                                       | Source type(S,C, or F),Source<br>Destination type(A or C),Dest<br>Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest<br>Gain  Interconnect ID number Source type(S,C, or F),Source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                                                                                    | #        | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12                                                                                                            |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12                                                                                                                                                       | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                                                                                    | #        | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1                                                                                                  |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12                                                                                                                                                       | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ID,Dest row #  ID,Source row #  ID,Dest row #  ID,Source row ID,Dest row #                                                                                                       | <b>#</b> | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1                                                                                             |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13                                                                                                                                           | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain                                                                                                                                                                                                                                                                                                                                                                                                                                            | ID,Dest row #  ID,Source row #  ID,Source row #  ID,Dest row #                                                                                                                   | <b>#</b> | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13                                                                             |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13                                                                                                                                     | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Destination type(A or C),Dest                                                                                                                                                                                                                                                                                                                                                                                                                   | ID,Dest row #  ID,Source row #  ID,Source row #  ID,Dest row #                                                                                                                   | <b>#</b> | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1                                                                                             |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13                                                                                                                                     | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain                                                                                                                                                                                                                                                                                                                                                                                                                                            | ID,Dest row #  ID,Source row #  ID,Source row #  ID,Dest row #                                                                                                                   | <b>#</b> | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1                                                                   |
| IN I | 10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13                                                                                                                                     | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number                                                                                                                                                                                                                                                                                                                 | ID,Dest row #  ID,Source row #  ID,Source row #  ID,Dest row #  ID,Source row #                                                                                                  | *<br>*   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1                                                              |
| IN I | 10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14                                                                                                                               | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source                                                                                                                                                                                                                                                                                  | ID,Dest row #  ID,Source row #                                                                               | *<br>*   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14                                              |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14                                                                                                             | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest                                                                                                                                                                                                                                                               | ID,Dest row #  ID,Source row #                                                                               | *<br>*   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1                                    |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14                                                                                                             | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source                                                                                                                                                                                                                                                                                  | ID,Dest row #  ID,Source row #                                                                               | *<br>*   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14                                              |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14                                                                                                             | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain                                                                                                                                                                                                                                              | ID,Dest row #  ID,Source row #                                                                               | *<br>*   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1                                    |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14                                                                                                       | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number                                                                                                                                                                                                                      | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                | #<br>#   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>3<br>C 1 13<br>A 13 1<br>1<br>1<br>4<br>C 1 14<br>A 14 1                                 |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>15<br>15                                                                                           | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain                                                                                                                                                                                                                                              | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                | #<br>#   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1<br>1                               |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>15<br>15<br>15                                                                                     | Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source Destination type(A or C),Dest Gain  Interconnect ID number Source type(S,C, or F),Source                                                                                                                                                                                                    | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                | #<br>#   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>1<br>C 1 14<br>A 14 1<br>1<br>15<br>C 1 15                |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>15<br>15<br>15                                                                               | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain                                                                                                                                                   | ID,Dest row #  ID,Source row #  ID,Dest row #                                                                | #<br>#   | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1<br>1<br>15<br>C 1 15<br>A 15 1     |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>15<br>15<br>15<br>15                                                                         | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number                                                                                                                           | ID, Dest row #  ID, Source row #                   | * * * *  | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1<br>1<br>15<br>C 1 15<br>A 15 1     |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>15<br>15<br>15<br>16<br>16                                                                         | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source | ID, Dest row #  ID, Source row # | * * * *  | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>3<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1<br>1<br>15<br>C 1 15<br>A 15 1<br>1 |
| IN I | 10<br>10<br>10<br>11<br>11<br>11<br>11<br>12<br>12<br>12<br>12<br>12<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>15<br>15<br>15<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16<br>16 | Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number Source type(S,C, or F), Source Destination type(A or C), Dest Gain  Interconnect ID number                                                                                                                           | ID, Dest row #  ID, Source row # | * * * *  | C 1 10<br>A 10 1<br>1<br>11<br>C 1 11<br>A 11 1<br>1<br>12<br>C 1 12<br>A 12 1<br>1<br>13<br>C 1 13<br>A 13 1<br>1<br>14<br>C 1 14<br>A 14 1<br>1<br>15<br>C 1 15<br>A 15 1     |

| IN       | 26  | Interconnect ID number                                                                        | 26              |
|----------|-----|-----------------------------------------------------------------------------------------------|-----------------|
| IN       |     | Source type(S,C, or F), Source ID, Source row #                                               | S 1 1           |
| IN       | 26  | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 1           |
| IN       | 26  | Gain                                                                                          | 1               |
|          |     |                                                                                               |                 |
| IN       |     | Interconnect ID number                                                                        | 27              |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                                               | S 2 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 2<br>1      |
| IN       | 21  | Gain                                                                                          | 1               |
| IN       | 28  | Interconnect ID number                                                                        | 28              |
| IN       |     | Source type(S,C, or F),Source ID,Source row #                                                 | s 3 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 3           |
| IN       | 28  | Gain                                                                                          | 1               |
|          |     |                                                                                               |                 |
| IN       |     | Interconnect ID number                                                                        | 29              |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                                               | S 4 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 4           |
| IN       | 29  | Gain                                                                                          | 1               |
| IN       | 30  | Interconnect ID number                                                                        | 30              |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                                               | S 4 2           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 5           |
| IN       |     | Gain                                                                                          | 1               |
|          |     |                                                                                               |                 |
| IN       | 31  | Interconnect ID number                                                                        | 31              |
| IN       | 31  | Source type(S,C, or F), Source ID, Source row #                                               | S 5 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 6           |
| IN       | 31  | Gain                                                                                          | 1               |
|          | 22  | Tabana and TD modern                                                                          | 22              |
| IN       |     | Interconnect ID number                                                                        | 32<br>S 5 2     |
| IN<br>IN |     | Source type(S,C, or F),Source ID,Source row # Destination type(A or C),Dest ID,Dest row #     | C 1 7           |
| IN       |     | Gain                                                                                          | 1               |
|          |     |                                                                                               | -               |
| IN       | 33  | Interconnect ID number                                                                        | 33              |
| IN       | 33  | Source type(S,C, or F), Source ID, Source row #                                               | S 5 3           |
| IN       | 33  | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 8           |
| IN       | 33  | Gain                                                                                          | 1               |
|          |     |                                                                                               |                 |
| IN       |     | Interconnect ID number                                                                        | 34<br>S 6 1     |
| IN<br>IN |     | Source type(S,C, or F), Source ID, Source row # Destination type(A or C), Dest ID, Dest row # | C 1 9           |
| IN       |     | Gain                                                                                          | 1               |
|          | J - | - Call                                                                                        | •               |
| IN       | 35  | Interconnect ID number                                                                        | 35              |
| IN       | 35  | Source type(S,C, or F), Source ID, Source row #                                               | s 7 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 10          |
| IN       | 35  | Gain                                                                                          | 1               |
| T27      | 2.  | Tabanaan Ta mushan                                                                            | 26              |
| IN       |     | Interconnect ID number                                                                        | 36              |
| IN<br>IN |     | Source type(S,C, or F),Source ID,Source row # Destination type(A or C),Dest ID,Dest row #     | S 8 1<br>C 1 11 |
| IN       |     | Gain                                                                                          | 1               |
| 714      | 50  | Gain                                                                                          | *               |
| IN       | 37  | Interconnect ID number                                                                        | 37              |
| IN       |     | Source type(S,C, or F), Source ID, Source row #                                               | S 9 1           |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 1 12          |
| IN       | 37  | Gain                                                                                          | 1               |
|          |     |                                                                                               | 3.0             |
| IN       |     | Interconnect ID number                                                                        | 38              |
| IN       |     | Source type(S,C, or F), Source ID, Source row # Destination type(A or C), Dest ID, Dest row # | S 10 1<br>C 2 1 |
| IN<br>IN |     | Gain                                                                                          | 1               |
| ***4     | 20  | V                                                                                             | -               |
| IN       | 39  | Interconnect ID number                                                                        | 39              |
|          |     | Source type(S,C, or F), Source ID, Source row #                                               | S 10 2          |
| IN       |     | Destination type(A or C), Dest ID, Dest row #                                                 | C 2 2           |
| IN       |     | Gain                                                                                          | 1               |
|          | _   |                                                                                               |                 |
| IN       |     | Interconnect ID number                                                                        | 40              |

| IN<br>IN<br>IN       | 40 Source type(S,C, or F),Source<br>40 Destination type(A or C),Dest<br>40 Gain                                |                  |   | S 10 3<br>C 2 3<br>1        |
|----------------------|----------------------------------------------------------------------------------------------------------------|------------------|---|-----------------------------|
| IN<br>IN<br>IN       | 41 Interconnect ID number<br>41 Source type(S,C, or F),Source<br>41 Destination type(A or C),Dest<br>41 Gain   |                  |   | 41<br>S 11 1<br>C 2 4<br>1  |
| IN<br>IN<br>IN       | 42 Interconnect ID number<br>42 Source type(S,C, or F),Source<br>42 Destination type(A or C),Dest<br>42 Gain   | •                |   | 42<br>S 11 2<br>C 2 5<br>1  |
| IN<br>IN<br>IN       | 43 Interconnect ID number 43 Source type(S,C, or F), Source 43 Destination type(A or C), Dest 43 Gain          |                  |   | 43<br>S 11 3<br>C 2 6<br>1  |
| IN<br>IN<br>IN       | 17 Interconnect ID number<br>17 Source type(S,C, or F),Source<br>17 Destination type(A or C),Dest<br>17 Gain   |                  |   | 17<br>C 2 1<br>A 26 1       |
| IN<br>IN<br>IN       | 18 Interconnect ID number<br>18 Source type(S,C, or F),Source<br>18 Destination type(A or C),Dest<br>18 Gain   |                  | # | 18<br>C 2 2<br>A 27 1       |
| IN<br>IN<br>IN       | 19 Interconnect ID number<br>19 Source type(S,C, or F),Source<br>19 Destination type(A or C),Dest<br>19 Gain   |                  | # | 19<br>C 2 3<br>A 28 1       |
| IN<br>IN<br>IN       | 20 Interconnect ID number<br>20 Source type(S,C, or F),Source<br>20 Destination type(A or C),Dest<br>20 Gain   |                  | # | 20<br>C 2 4<br>A 23 1       |
| IN<br>IN<br>IN       | 21 Interconnect ID number<br>21 Source type(S,C, or F),Source<br>21 Destination type(A or C),Dest<br>21 Gain   |                  | * | 21<br>C 2 5<br>A 24 1       |
|                      | <pre>22 Interconnect ID number 22 Source type(S,C, or F),Source 22 Destination type(A or C),Dest 22 Gain</pre> |                  | # | 22<br>C 2 6<br>A 25 1       |
| IN<br>IN<br>IN       | 23 Interconnect ID number 23 Source type(S,C, or F),Source 23 Destination type(A or C),Dest 23 Gain            |                  | # | 23<br>s 17 1<br>c 1 13<br>1 |
| IN<br>IN<br>IN       | 24 Interconnect ID number<br>24 Source type(S,C, or F),Source<br>24 Destination type(A or C),Dest<br>24 Gain   |                  | * | 24<br>S 17 2<br>C 1 14<br>1 |
| IN<br>IN<br>IN<br>IN | 25 Interconnect ID number<br>25 Source type(S,C, or F),Source<br>25 Destination type(A or C),Dest<br>25 Gain   |                  | # | 25<br>S 17 3<br>C 1 15<br>1 |
| IN<br>IN<br>IN       | 44 Interconnect ID number<br>44 Source type(S,C, or F),Source<br>44 Destination type(A or C),Dest<br>44 Gain   | ID, Source row # | * | 44<br>S 17 4<br>C 1 16<br>1 |
| IN<br>IN             | 45 Interconnect ID number<br>45 Source type(S,C, or F),Source                                                  | ID, Source row   | # | 45<br>S 17 5                |

| IN<br>IN | 45 Destination type(A or C), Dest ID, Dest row # 45 Gain                                            | C 1 17              |
|----------|-----------------------------------------------------------------------------------------------------|---------------------|
|          | 46 Interconnect ID number 46 Source type(S,C, or F), Source ID, Source row #                        | 46<br>S 17 6        |
| IN       |                                                                                                     | C 1 18              |
| IN       | 46 Gain                                                                                             | 1                   |
|          | 47 Interconnect ID number 47 Source type(S,C, or F), Source ID, Source row #                        | <b>47</b><br>S 17 7 |
| IN<br>IN |                                                                                                     | C 1 19              |
| IN       | 47 Gain                                                                                             | 1                   |
|          | 48 Interconnect ID number                                                                           | 48<br>S 17 8        |
| IN       | 48 Source type(S,C, or F), Source ID, Source row # 48 Destination type(A or C), Dest ID, Dest row # | C 1 20              |
| IN       | 48 Gain                                                                                             | 1                   |
| IN       | 49 Interconnect ID number                                                                           | 49                  |
| IN<br>IN | 49 Source type(S,C, or F), Source ID, Source row # 49 Destination type(A or C), Dest ID, Dest row # | S 17 9<br>C 1 21    |
| IN       | 49 Gain                                                                                             | 1                   |
| IN       | 50 Interconnect ID number                                                                           | 50                  |
| IN       | 50 Source type(S,C, or F), Source ID, Source row #                                                  | S 19 1              |
| IN       |                                                                                                     | C 3 1               |
| IN       | 50 Gain                                                                                             | 1                   |
|          | 51 Interconnect ID number                                                                           | 51                  |
|          | 51 Source type(S,C, or F), Source ID, Source row #                                                  | S 20 1              |
| IN<br>IN | 51 Destination type(A or C),Dest ID,Dest row # 51 Gain                                              | C 3 2<br>1          |
| TIA      | 31 Gain                                                                                             |                     |
|          | 52 Interconnect ID number                                                                           | 52                  |
|          | 52 Source type(S,C, or F), Source ID, Source row #                                                  | C 3 1<br>A 29 1     |
| IN       | 52 Destination type(A or C), Dest ID, Dest row # 52 Gain                                            | 1                   |
|          |                                                                                                     |                     |
|          | 53 Interconnect ID number                                                                           | 53<br>C 3 2         |
| IN       | 53 Source type(S,C, or F), Source ID, Source row # 53 Destination type(A or C), Dest ID, Dest row # | A 30 1              |
| IN       | 53 Gain                                                                                             | 1                   |
|          | AEROD                                                                                               |                     |
|          |                                                                                                     |                     |
| AE       | 1 Aerodynamic Model ID #                                                                            | 1<br>1 13           |
| AE<br>AE | 1 Body ID, Center of Pressure Node ID 1 Atmosphere Type (C,J,M)                                     | 1 13<br>J           |
| AE       | 1 Constant Density for Atmosphere Type=C                                                            |                     |
| ΑE       | 1 Model Type (P,C,T,B)                                                                              | T                   |
| AE       | 1 Dimensions D,L (meters)                                                                           |                     |
| AE       | 1 Unit Normal Vector x,y,z 1 Aero Ref Area, Ref Length (meters)                                     | 16.6051 2.2990      |
| AE<br>AE | 1 Name of Aero Coefficient Table Input File                                                         | .\newttae.dat       |
| AE       | 1 Axial unit vector in body (alpha=0,phi=0)                                                         | 0. 0. 1.            |
| AE       | 1 Vert unit vector in body (alpha=90,phi=0)                                                         | .70717071 0.        |
| AE       | 1 Horiz unit <b>ve</b> ctor in body (alpha=90,phi=90)                                               | .7071 .7071 0.      |
|          |                                                                                                     |                     |

# Appendix G

#### XFERFN.DAT

```
2
1, 12, 14,
1.172e-015,1.791e-013,1.689e-011,9.742e-010,
3.67e-008,9.875e-007,2.021e-005,0.0003199,
0.003825,0.03284,0.1885,0.6426,0.9794
1.172e-015,8.378e-015,1.073e-011,6.83e-011,
1.945e-008,1.199e-007,1.294e-005,7.784e-005
0.003281,0.019,0.2916,1.54,
3.265,3.001,1.0,
2, 12, 14,
1.172e-015,1.791e-013,1.689e-011,9.742e-010,
3.67e-008,9.875e-007,2.021e-005,0.0003199,
0.003825,0.03284,0.1885,0.6426,0.9794
1.172e-015,8.378e-015,1.073e-011,6.83e-011,
1.945e-008,1.199e-007,1.294e-005,7.784e-005,
0.003281,0.019,0.2916,1.54,
3.265,3.001,1.0,
```

# Appendix H

# INPUT FILE DEFINING MODEL FOR THE FLEXIBLE BODY MODEL APPROACH TO SLOSH DYNAMICS ANALYSIS IMPEG\_GPB\_MS.INT

#### TREETOPS REV 10X 1/10/02

#### SIM CONTROL

| SI<br>SI | 0 Title<br>0 Simulation stop time                                 | GPB MODEL FOR 2002<br>20000 |
|----------|-------------------------------------------------------------------|-----------------------------|
| SI       | 0 Plot data interval                                              | 5                           |
| SI       | 0 Integration type (R,S or U)                                     | R                           |
| SI       | 0 Step size (sec)                                                 | 0.1                         |
| SI       | O Sandia integration absolute and relative error                  |                             |
| SI       | 0 RK78 ODE solver absolute error and first step size              |                             |
| SI       | 0 Linearization option (L,Z or N)                                 | N                           |
| SI       | 0 Restart option (Y/N)                                            | N                           |
| SI       | 0 Contact force computation option (Y/N)                          | Y                           |
| SI       | 0 Constraint force computation option (Y/N)                       | N                           |
| SI       | <pre>0 Small angle speedup option (All, Bypass, First, Nth)</pre> | A                           |
| SI       | 0 Mass matrix speedup option (All, Bypass, First, Nth)            | A                           |
| SI       | 0 Non-Linear speedup option (All, Bypass, First, Nth)             | A                           |
| SI       | O Constraint speedup option (All, Bypass, First, Nth)             | A                           |
| SI       | 0 Constraint stabilization option (Y/N)                           | N                           |
| SI       | 0 Stabilization epsilon                                           |                             |

#### GENGRAV

| GG | <pre>0 Gravity, earth sphere/nonsphere/user (S/N/U)?</pre> | N         |
|----|------------------------------------------------------------|-----------|
| GG | 1 Input gravity constants: GME, ERAD, EMASS                |           |
| GG | 1 Spherical or Nonspherical (S/N)?                         |           |
| GG | 1 Gravity Potential Harmonics J2, J3, J4                   |           |
| GG | <pre>0 English (ft-slug-s) or metric (m-kg-s) (E/M)?</pre> | M         |
| GG | 0 Day, Month, Year,                                        | 21 6 2003 |
| GG | 0 GMT & sim time 0 (minutes past midnight,                 | 720       |
| GG | 0 Solar Pressure forces Y/N?                               | N         |
| GG | 0 Input new data for aero model? (Y/N)                     | Y         |
| GG | O Solar flux F10 for aero model                            | 230       |
| GG | 0 Solar flux, 81 day average F10B                          | 230       |
| GG | O Geomagnetic index, GEAP                                  | 400       |
|    |                                                            |           |

#### BODY

| BO | 1 Body ID number                                     | 1 |
|----|------------------------------------------------------|---|
| во | 1 Type (Rigid, Flexible, NASTRAN)                    | R |
| во | 1 Number of modes                                    |   |
| BO | 1 Modal calculation option (0, 1 or 2)               |   |
| во | 1 Foreshortening Option (Y/N)                        |   |
| BO | 1 Model reduction method (NO,MS,MC,CC,QM,CV)         |   |
| BO | 1 NASTRAN data file FORTRAN unit number (40 - 60)    |   |
| BO | 1 Number of augmented nodes (0 if none)              |   |
| во | 1 Damping matrix option (NS,CD,HL,SD)                |   |
| BO | 1 Constant damping ratio                             |   |
| BO | 1 Low frequency, High frequency ratios               |   |
| BO | 1 Mode ID number, damping ratio                      |   |
| BO | 1 Conversion factors: Length, Mass, Force            |   |
| BO | 1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) | 1 |
|    |                                                      |   |

```
1 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                        5230.2 5147.5 3693.4
     1 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                        19.3 -6 0
 BO
     1 Mass (kg)
                                                                        3182.8
     1 Number of Nodes
BO
                                                                        13
BO
      1 Node ID, Node coord. (meters) x,y,z
                                                                        1 0 -0.0002 0.8647
BO
     1 Node ID, Node coord. (meters) x,y,z
                                                                        2 0 -0.0002 0.8647
BO
     1 Node ID, Node coord. (meters) x,y,z
                                                                       3 0 1.0467 0.6380
     1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                       4 0 0 0.10033
                                                                       5 -1.19 0 2.51
     1 Node ID, Node coord. (meters) x,y,z
                                                                       6 1.19 0 2.51
во
     1 Node ID, Node coord. (meters) x,y,z
                                                                       7 -1.19 0 -1.9
     1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
                                                                       8 1.19 0 -1.9
BO
                                                                       9 0 0 -.10033
     1 Node ID, Node coord. (meters) x,y,z
                                                                       10 0 0 -.18283
    1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
1 Node ID, Node coord. (meters) x,y,z
BO
                                                                       11 0 0 -.26533
BO
                                                                       12 0 0 -.34783
                                                                       13 0 0 0.10937
    1 Node ID, Node structual joint ID
BO
     2 Body ID number
                                                                        2
BO 2 Type (Rigid, Flexible, NASTRAN)
во
     2 Number of modes
BO
     2 Modal calculation option (0, 1 or 2)
     2 Foreshortening Option (Y/N)
BO
    2 Model reduction method (NO,MS,MC,CC,QM,CV)
     2 NASTRAN data file FORTRAN unit number (40 - 60)
во
     2 Number of augmented nodes (0 if none)
BO 2 Damping matrix option (NS,CD,HL,SD)
BO
BO
     2 Constant damping ratio
     2 Low frequency, High frequency ratios
     2 Mode ID number, damping ratio
BO 2 Conversion factors: Length, Mass, Force
BO
     2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
во
     2 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                        .00001 .00001 .00001
     2 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                        0 0 0
BO
BO
     2 Mass (kg)
                                                                        .076
     2 Number of Nodes
BO 2 Node ID, Node coord. (meters) x,y,z
                                                                       1 0 0 0
BO 2 Node ID, Node structual joint ID
BO
     3 Body ID number
                                                                       3
BO 3 Type (Rigid, Flexible, NASTRAN)
                                                                       R
BO
    3 Number of modes
     3 Modal calculation option (0, 1 or 2)
BO
BO 3 Foreshortening option (Y/N)
BO 3 Model reduction method (NO, MS, MC, CC, QM, CV)
     3 NASTRAN data file FORTRAN unit number (40 - 60)
BO
BO
     3 Number of augmented nodes (0 if none)
BO
    3 Damping matrix option (NS,CD,HL,SD)
     3 Constant damping ratio
во
BO
     3 Low frequency, High frequency ratios
     3 Mode ID number, damping ratio
BO
     3 Conversion factors: Length, Mass, Force
BO
     3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
     3 Moments of inertia (kg-m2) Ixx, Iyy, Izz
BO
                                                                       9.1999324E-6 9.199954E-6 9.2E-6
BO
     3 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                       0 0 0
BO
     3 Mass (kg)
                                                                       0.06335
BO
     3 Number of Nodes
     3 Node ID, Node coord. (meters) x,y,z
                                                                       1000
RΩ
     3 Node ID, Node coord. (meters) x,y,z
                                                                       2 0 0 -5.08E-8
     3 Node ID, Node structual joint ID
BO
     4 Body ID number
BO
     4 Type (Rigid, Flexible, NASTRAN)
                                                                       R
во
     4 Number of modes
BO
     4 Modal calculation option (0, 1 or 2)
BO
     4 Foreshortening option (Y/N)
BO
     4 Model reduction method (NO, MS, MC, CC, QM, CV)
RΩ
     4 NASTRAN data file FORTRAN unit number (40 - 60)
     4 Number of augmented nodes (0 if none)
     4 Damping matrix option (NS,CD,HL,SD)
```

```
4 Constant damping ratio
     4 Low frequency, High frequency ratios
     4 Mode ID number, damping ratio
     4 Conversion factors: Length, Mass, Force
во
BO
      4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
     4 Moments of inertia (kg-m2) Ixx, Iyy, Izz
BO
                                                                      9.1999324E-6 9.199954E-6 9.2E-6
BO
     4 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                      0 0 0
BO
     4 Mass (kg)
                                                                      .06335
BO
     4 Number of Nodes
                                                                      2
     4 Node ID, Node coord. (meters) x,y,z
                                                                      1000
     4 Node ID, Node coord. (meters) x,y,z
                                                                      2 0 0 -5.08E-8
BO
во
     4 Node ID, Node structual joint ID
BO
     5 Body ID number
                                                                      5
     5 Type (Rigid, Flexible, NASTRAN)
BO
                                                                      R
BO
     5 Number of modes
     5 Modal calculation option (0, 1 or 2)
BO
     5 Foreshortening option (Y/N)
     5 Model reduction method (NO, MS, MC, CC, QM, CV)
BO
     5 NASTRAN data file FORTRAN unit number (40 - 60)
     5 Number of augmented nodes (0 if none)
BO
     5 Damping matrix option (NS,CD,HL,SD)
BO
     5 Constant damping ratio
     5 Low frequency, High frequency ratios
BO
     5 Mode ID number, damping ratio
     5 Conversion factors: Length, Mass, Force
BO
     5 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                      9.1999324E-6 9.199954E-6 9.2E-6
     5 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                      0 0 0
BO
     5 Products of inertia (kg-m2) Ixy, Ixz, Iyz
BO
     5 Mass (kg)
                                                                      .06335
     5 Number of Nodes
BO
                                                                      1 0 0 0
BO
     5 Node ID, Node coord. (meters) x,y,z
     5 Node ID, Node coord. (meters) x,y,z
5 Node ID, Node structual joint ID
BO
                                                                      2 0 0 -5.08E-8
BO
BO
     6 Body ID number
                                                                      6
     6 Type (Rigid, Flexible, NASTRAN)
                                                                      R
    6 Number of modes
BO
    6 Modal calculation option (0, 1 or 2)
BO
     6 Foreshortening option (Y/N)
BO
     6 Model reduction method (NO, MS, MC, CC, QM, CV)
    6 NASTRAN data file FORTRAN unit number (40 - 60)
    6 Number of augmented nodes (0 if none)
BO
     6 Damping matrix option (NS,CD,HL,SD)
    6 Constant damping ratio
    6 Low frequency, High frequency ratios
     6 Mode ID number, damping ratio
BO
     6 Conversion factors: Length, Mass, Force
BO
     6 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
                                                                      9.1999324E-6 9.199954E-6 9.2E-6
     6 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                      0 0 0
     6 Products of inertia (kg-m2) Ixy, Ixz, Iyz
BO
                                                                      .06335
     6 Mass (kg)
     6 Number of Nodes
BO
                                                                      2
                                                                      1 0 0 0
BO
     6 Node ID, Node coord. (meters) x,y,z
BO
     6 Node ID, Node coord. (meters) x,y,z
                                                                     2 0 0 -5.08E-8
    6 Node ID, Node structual joint ID
                                                                      7
     7 Body ID number
     7 Type (Rigid, Flexible, NASTRAN)
                                                                      F
BO
     7 Number of modes
                                                                      33
BO
     7 Modal calculation option (0, 1 or 2)
     7 Foreshortening option (Y/N)
BO
     7 Model reduction method (NO, MS, MC, CC, QM, CV)
     7 NASTRAN data file FORTRAN unit number (40 - 60)
     7 Number of augmented nodes (0 if none)
BO
     7 Damping matrix option (NS,CD,HL,SD)
BO
     7 Constant damping ratio
     7 Low frequency, High frequency ratios
BO
     7 Mode ID number, damping ratio
    7 Conversion factors: Length, Mass, Force
    7 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)
```

```
7 Moments of inertia (kg-m2) Ixx, Iyy, Izz
                                                                        0 0 0
         7 Products of inertia (kg-m2) Ixy, Ixz, Iyz
                                                                        0 0 0
    BO
         7 Mass (kg)
          7 Number of Nodes
     BO
                                                                        2
    BO 7 Node ID, Node coord. (meters) x,y,z
                                                                        1 0 0 0
    BO 7 Node ID, Node coord. (meters) x,y,z
                                                                        2 0 0 0
    BO 7 Node ID, Node structual joint ID
           HINGE
    HI 1 Hinge ID number
                                                                        1
    HI 1 Inboard body ID, Outboard body ID
    HI 1 "p" node ID, "q" node ID
         1 Number of rotation DOFs, Rotation option (F or G)
    HI 1 L1 unit vector in inboard body coord. x,y,z
HI 1 L1 unit vector in outboard body coord. x,y,z
    HI 1 L2 unit vector in inboard body coord. x,y,z
    ΗI
         1 L2 unit vector in outboard body coord. x,y,z
    HI 1 L3 unit vector in inboard body coord. x,y,z
                                                                       0 0 1
    HI 1 L3 unit vector in outboard body coord. x,y,z
                                                                        0 0 1
    HI 1 Initial rotation angles (deg) -16.7408 16.8411 -90 -16.739107675801 16.838172287528
-90.0
    HI 1 Initial rotation rates (deg/sec)
                                                                        0 0 1.8
    HI 1 Rotation stiffness (newton-meters/rad)
                                                                        0 0 0
    ΗI
         1 Rotation damping (newton-meters/rad/sec)
                                                                        0 0 0
    HI 1 Null torque angles (deg)
                                                                        0 0 0
    HI 1 Number of translation DOFs
    HI 1 First translation unit vector g1
HI 1 Second translation unit vector g2
                                                                        1 0 0
                                                                        0 1 0
    HI 1 Third translation unit vector g3
                                                                       0 0 1
                                                                      2021331.3322 0 -6720778.19992
        1 Initial translation (meters)
    HΙ
         1 Initial translation velocity (meters/sec)
    ΗI
                                                                       0 -7533.0 0
        1 Translation stiffness (newtons/meters)
                                                                       0 0 0
    HI
    ΗĮ
        1 Translation damping (newtons/meter/sec)
                                                                       0 0 0
        1 Null force translations
                                                                        0 0 0
    HI 2 Hinge ID number
    HI
         2 Inboard body ID, Outboard body ID
                                                                        1 2
         2 "p" node ID, "q" node ID
                                                                        4 1
    HI
         2 Number of rotation DOFs, Rotation option (F or G)
    нт
        2 L1 unit vector in inboard body coord. x,y,z
                                                                        1 0 0
        2 L1 unit vector in outboard body coord. x,y,z
                                                                        1 0 0
         2 L2 unit vector in inboard body coord. x,y,z
       2 L2 unit vector in outboard body coord. x,y,z
    HI 2 L3 unit vector in inboard body coord. x,y,z
                                                                       0 0 1
         2 L3 unit vector in outboard body coord. x,y,z
    нт
                                                                        0 0 1
         2 Initial rotation angles (deg)
                                                                        0 0 0
    HT
        2 Initial rotation rates (deg/sec)
         2 Rotation stiffness (newton-meters/rad)
        2 Rotation damping (newton-meters/rad/sec)
    HI
       2 Null torque angles (deg)
        2 Number of translation DOFs
    HI
                                                                        3
    HI
         2 First translation unit vector g1
                                                                        1 0 0
        2 Second translation unit vector g2
    HI
                                                                        0 1 0
    HT
        2 Third translation unit vector g3
                                                                        0 0 1
         2 Initial translation (meters)
                                                                        0 0 0
    HI
         2 Initial translation velocity (meters/sec)
         2 Translation stiffness (newtons/meters)
    нт
         2 Translation damping (newtons/meter/sec)
                                                                        0 0 0
    ΗĪ
         2 Null force translations
                                                                        0 0 0
    HT
        3 Hinge ID number
                                                                        3
        3 Inboard body ID, Outboard body ID
3 "p" node ID, "q" node ID
    ΗI
                                                                        1 3
    HT
                                                                        9 2
        3 No of rotation DOFs, Hinge 1 rotation option(F/G)
                                                                       1 0 0
        3 L1 unit vector in inboard body coord. x,y,z
         3 L1 unit vector in outboard body coord. x,y,z
                                                                        1 0 0
        3 L2 unit vector in inboard body coord. x,y,z
    ΗI
       3 L2 unit vector in outboard body coord. x,y,z
   HI 3 L3 unit vector in inboard body coord. x,y,z
                                                                        0 0 1
```

| HI       | 3 L3 unit vector in outboard body coord. x,y,z                                                 | 0 0 1             |
|----------|------------------------------------------------------------------------------------------------|-------------------|
| HI       | 3 Initial rotation angles (deg)                                                                | 0 0 0             |
| ΗI       | 3 Initial rotation rates (deg/sec)                                                             |                   |
| HI       | <pre>3 Rotation stiffness (newton-meters/rad)</pre>                                            |                   |
| HI       | <pre>3 Rotation damping (newton-meters/rad/sec)</pre>                                          |                   |
| HI       | 3 Null torque angles (deg)                                                                     |                   |
| HI       | 3 Number of translation DOFs                                                                   | 3                 |
| HI       | 3 First translation unit vector g1                                                             | 1 0 0             |
| HI       | 3 Second translation unit vector g2                                                            | 0 1 0             |
| HI<br>HI | 3 Third translation unit vector g3 3 Initial translation (meters)                              | 0 0 1<br>0 0 0    |
| HI       | 3 Initial translation (meters) 3 Initial translation velocity (meters/sec)                     | 0 0 0             |
| HI       | 3 Translation stiffness (newtons/meters)                                                       | 10. 10. 10.       |
| HI       | 3 Translation damping (newtons/meter/sec)                                                      | 1.125 1.125 1.125 |
| HI       | 3 Null force translations                                                                      | 0 0 0             |
|          | A 411                                                                                          |                   |
| HI       | 4 Hinge ID number                                                                              | 4                 |
| HI<br>HI | 4 Inboard body ID, Outboard body ID<br>4 "p" node ID, "q" node ID                              | 1 4               |
| HI       | 4 Number of rotation DOFs, Rotation option (F or G)                                            | 10 2<br>0         |
| HI       | 4 L1 unit vector in inboard body coord. x,y,z                                                  | 1 0 0             |
| HI       | 4 L1 unit vector in outboard body coord. x,y,z                                                 | 1 0 0             |
| HI       | 4 L2 unit vector in inboard body coord. x,y,z                                                  |                   |
| HI       | 4 L2 unit vector in outboard body coord. x,y,z                                                 |                   |
| HI       | 4 L3 unit vector in inboard body coord. x,y,z                                                  | 0 0 1             |
| ΗI       | 4 L3 unit vector in outboard body coord. x,y,z                                                 | 0 0 1             |
| HI       | 4 Initial rotation angles (deg)                                                                | 0 0 0             |
| HI       | 4 Initial rotation rates (deg/sec)                                                             |                   |
| HI<br>HI | <pre>4 Rotation stiffness (newton-meters/rad) 4 Rotation damping (newton-meters/rad/sec)</pre> |                   |
| HI       | 4 Null torque angles (deg)                                                                     |                   |
| HI       | 4 Number of translation DOFs                                                                   | 3                 |
| HI       | 4 First translation unit vector g1                                                             | 1 0 0             |
| HI       | 4 Second translation unit vector g2                                                            | 0 1 0             |
| HI       | 4 Third translation unit vector g3                                                             | 0 0 1             |
| HI       | 4 Initial translation (meters)                                                                 | 0 0 0             |
| HI       | 4 Initial translation velocity (meters/sec)                                                    | 0 0 0             |
| HI       | 4 Translation stiffness (newtons/meters)                                                       | 10 10 10          |
| HI<br>HI | 4 Translation damping (newtons/meter/sec) 4 Null force translations                            | 1.125 1.125 1.125 |
| пт       | 4 Null lorce translations                                                                      | 0 0 0             |
| HI       | 5 Hinge ID number                                                                              | 5                 |
| HI       | 5 Inboard body ID, Outboard body ID                                                            | 1 5               |
| HI       | 5 "p" node ID, "q" node ID                                                                     | 11 2              |
| HI<br>HI | 5 Number of rotation DOFs 5 L1 unit vector in inboard body coord. x,y,z                        | 0<br>1 0 0        |
| HI       | 5 L1 unit vector in outboard body coord. x,y,z                                                 | 1 0 0             |
| HI       | 5 L2 unit vector in inboard body coord. x,y,z                                                  | 100               |
| HI       | 5 L2 unit vector in outboard body coord. x,y,z                                                 |                   |
| HI       | 5 L3 unit vector in inboard body coord. x,y,z                                                  | 0 0 1             |
| HI       | 5 L3 unit vector in outboard body coord. x,y,z                                                 | 0 0 1             |
| HI       | 5 Initial rotation angles (deg)                                                                | 0 0 0             |
| HI       | 5 Initial rotation rates (deg/sec) 5 Rotation stiffness (newton-meters/rad)                    |                   |
| HI<br>HI | 5 Rotation Stiffness (newton-meters/rad) 5 Rotation damping (newton-meters/rad/sec)            |                   |
| HI       | 5 Null torque angles (deg)                                                                     |                   |
| HI       | 5 Number of translation DOFs                                                                   | 3                 |
| HI       | 5 First translation unit vector g1                                                             | 1 0 0             |
| HI       | 5 Second translation unit vector g2                                                            | 0 1 0             |
| HI       | 5 Third translation unit vector g3                                                             | 0 0 1             |
| HI       | 5 Initial translation (meters)                                                                 | 0 0 0             |
| HI       | 5 Initial translation velocity (meters/sec)                                                    | 0 0 0             |
| HI       | 5 Translation stiffness (newtons/meters)                                                       | 10 10 10          |
| HI<br>HI | 5 Translation damping (newtons/meter/sec) 5 Null force translations                            | 1.125 1.125 1.125 |
| uī       | 3 Muli folde Claustacions                                                                      | 0 0 0             |
| HI       | 6 Hinge ID number                                                                              | 6                 |
| HI       | 6 Inboard body ID, Outboard body ID                                                            | 1 6               |
| HI       | 6 "p" node ID, "q" node ID                                                                     | 12 2              |
| HI       | 6 Number of rotation DOFs                                                                      | 0                 |
| HI       | 6 L1 unit vector in inboard body coord. x,y,z                                                  | 1 0 0             |
|          |                                                                                                |                   |

| HI<br>HI | 6 L1 unit vector in outboard body coord. x,y,z 6 L2 unit vector in inboard body coord. x,y,z 6 L2 unit vector in outboard body coord. x,y,z | 1 0 0             |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| HI       | 6 L3 unit vector in inboard body coord. x,y,z                                                                                               | 0 0 1             |
| HI       | 6 L3 unit vector in outboard body coord. x,y,z                                                                                              | 0 0 1             |
| HI       | 6 Initial rotation angles (deg)                                                                                                             | 0 0 0             |
| HI<br>HI | 6 Initial rotation rates (deg/sec) 6 Rotation stiffness (newton-meters/rad)                                                                 |                   |
| HI       | 6 Rotation damping (newton-meters/rad/sec)                                                                                                  |                   |
| HI       | 6 Null torque angles (deg)                                                                                                                  |                   |
| HI       | 6 Number of translation DOFs                                                                                                                | 3                 |
| HI       | 6 First translation unit vector g1                                                                                                          | 1 0 0             |
| HI       | 6 Second translation unit vector g2                                                                                                         | 0 1 0             |
| HI<br>HI | 6 Third translation unit vector g3                                                                                                          | 0 0 1             |
| HI       | 6 Initial translation (meters) 6 Initial translation velocity (meters/sec)                                                                  | 0 0 0             |
| HI       | 6 Translation stiffness (newtons/meters)                                                                                                    | 10 10 10          |
| HI       | 6 Translation damping (newtons/meter/sec)                                                                                                   | 1.125 1.125 1.125 |
| HI       | 6 Null force translations                                                                                                                   | 0 0 0             |
|          |                                                                                                                                             | _                 |
| HI       | 7 Hinge ID number                                                                                                                           | 7                 |
| HI<br>HI | 7 Inboard body ID, Outboard body ID 7 "p" node ID, "q" node ID                                                                              | 1 7<br>2 2        |
| HI       | 7 Number of rotation DOFs, Rotation option (F or G)                                                                                         | 0                 |
| HI       | 7 L1 unit vector in inboard body coord. x,y,z                                                                                               | 1 0 0             |
| ΗI       | 7 L1 unit vector in outboard body coord. x,y,z                                                                                              | 1 0 0             |
| HI       | 7 L2 unit vector in inboard body coord. x,y,z                                                                                               |                   |
| HI       | 7 L2 unit vector in outboard body coord. x,y,z                                                                                              |                   |
| HI       | 7 L3 unit vector in inboard body coord. x,y,z                                                                                               | 0 0 1             |
| HI<br>HI | 7 L3 unit vector in outboard body coord. x,y,z 7 Initial rotation angles (deg)                                                              | 0 0 1             |
| HI       | 7 Initial rotation rates (deg/sec)                                                                                                          | 0 0 0             |
| HI       | 7 Rotation stiffness (newton-meters/rad)                                                                                                    |                   |
| HI       | 7 Rotation damping (newton-meters/rad/sec)                                                                                                  |                   |
| ΗI       | 7 Null torque angles (deg)                                                                                                                  | _                 |
| HI       | 7 Number of translation DOFs                                                                                                                | 0                 |
| HI       | 7 First translation unit vector g1 7 Second translation unit vector g2                                                                      | 100               |
| HI       | 7 Second translation unit vector g2 7 Third translation unit vector g3                                                                      | 0 0 1             |
| HI       | 7 Initial translation (meters)                                                                                                              | 0 0 0             |
| HI       | 7 Initial translation velocity (meters/sec)                                                                                                 |                   |
| HI       | 7 Translation stiffness (newtons/meters)                                                                                                    |                   |
| HI       | 7 Translation damping (newtons/meter/sec)                                                                                                   |                   |
| HI       | 7 Null force translations                                                                                                                   |                   |
|          | SENSOR                                                                                                                                      |                   |
| SE<br>SE | 1 Sensor ID number<br>1 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)                                                          | 1<br>G            |
| SE       | 1 Mounting point body ID, Mounting point node ID                                                                                            | 1 3               |
| SE       | 1 Second mounting point body ID, Second node ID                                                                                             |                   |
| SE       | 1 Input axis unit vector (IA) x,y,z                                                                                                         | 0 0 1             |
| SE       | 1 Mounting point Hinge index, Axis index                                                                                                    |                   |
| SE<br>SE | 1 First focal plane unit vector (Fp1) x,y,z<br>1 Second focal plane unit vector (Fp2) x,y,z                                                 |                   |
| SE       | 1 Sun/Star unit vector (Us) x,y,z                                                                                                           |                   |
| SE       | 1 Velocity Aberration Option (Y/N)                                                                                                          |                   |
| SE       | 1 Euler Angle Sequence (1-6)                                                                                                                |                   |
| SE       | 1 CMG ID number and Gimbal number                                                                                                           |                   |
| SE       | 1 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])                                                                                      |                   |
| SE       | 2 Sensor ID number                                                                                                                          | 2                 |
| SE       | 2 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)                                                                                | G                 |
| SE       | 2 Mounting point body ID, Mounting point node ID                                                                                            | 1 3               |
| SE       | 2 Second mounting point body ID, Second node ID                                                                                             |                   |
| SE       | 2 Input axis unit vector (IA) x,y,z                                                                                                         | 0 1 0             |
| SE       | 2 Mounting point Hinge index, Axis index                                                                                                    |                   |
| SE<br>SE | 2 First focal plane unit vector (Fp1) x,y,z<br>2 Second focal plane unit vector (Fp2) x,y,z                                                 |                   |
| SE       | 2 Sun/Star unit vector (Us) x,y,z                                                                                                           |                   |
|          | **************************************                                                                                                      |                   |

```
2 Velocity Aberration Option (Y/N)
          2 Euler Angle Sequence (1-6)
          2 CMG ID number and Gimbal number
          2 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
          3 Sensor ID number
          3 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
     SE
          3 Mounting point body ID, Mounting point node ID
     SE
          3 Second mounting point body ID, Second node ID
                                                                          1 0 0
          3 Input axis unit vector (IA) x,y,z
          3 Mounting point Hinge index, Axis index
     SE
          3 First focal plane unit vector (Fp1) x,y,z
          3 Second focal plane unit vector (Fp2) x,y,z
          3 Sun/Star unit vector (Us) x,y,z
     SE
          3 Velocity Aberration Option (Y/N)
          3 Euler Angle Sequence (1-6)
          3 CMG ID number and Gimbal number
          3 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
          4 Sensor ID number
          4 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                          ST
    SE
          4 Mounting point body ID, Mounting point node ID
    SE
         4 Second mounting point body ID, Second node ID
         4 Input axis unit vector (IA) x,y,z
         4 Mounting point Hinge index, Axis index
                                                                          1 0 0
         4 First focal plane unit vector (Fp1) x,y,z
         4 Second focal plane unit vector (Fp2) x,y,z
    SE
                                                                          -0.2756889168 0.2897184368
          4 Sun/Star unit vector (Us) x,y,z
    SE
0.9165472429
    SE
         4 Velocity Aberration Option (Y/N)
         4 Euler Angle Sequence (1-6)
         4 CMG ID number and Gimbal number
          4 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
    SE
          5 Sensor ID number
         5 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
    SE
         5 Mounting point body ID, Mounting point node ID
                                                                          1 4
         5 Second mounting point body ID, Second node ID 5 Input axis unit vector (IA) x,y,z
         5 Mounting point Hinge index, Axis index
    SE
         5 First focal plane unit vector (Fp1) x,y,z
    SE
         5 Second focal plane unit vector (Fp2) x,y,z
         5 Sun/Star unit vector (Us) x,y,z
    SE
    SE
         5 Velocity Aberration Option (Y/N)
         5 Euler Angle Sequence (1-6)
    SE
         5 CMG ID number and Gimbal number
         5 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
    SE
         6 Sensor ID number
         6 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                          AC
    SE
         6 Mounting point body ID, Mounting point node ID
                                                                          2 1
         6 Second mounting point body ID, Second node ID
         6 Input axis unit vector (IA) x,y,z
                                                                          1 0 0
         6 Mounting point Hinge index, Axis index
    SE
    SE
         6 First focal plane unit vector (Fp1) x,y,z
         6 Second focal plane unit vector (Fp2) x,y,z
    SE
         6 Sun/Star unit vector (Us) x,y,z
         6 Velocity Aberration Option (Y/N)
    SE
         6 Euler Angle Sequence (1-6)
    SE
         6 CMG ID number and Gimbal number
    SE
         6 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
    SE
         7 Sensor ID number
    SE
         7 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                          AC
         7 Mounting point body ID, Mounting point node ID
    SE
                                                                          2 1
    SE
         7 Second mounting point body ID, Second node ID
         7 Input axis unit vector (IA) x,y,z
                                                                          0 1 0
    SE
    SE
         7 Mounting point Hinge index, Axis index
         7 First focal plane unit vector (Fp1) x,y,z
    SE
    SE
         7 Second focal plane unit vector (Fp2) x,y,z
         7 Sun/Star unit vector (Us) x,y,z
```

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7 Velocity Aberration Option (Y/N)
SE
     7 Euler Angle Sequence (1-6)
     7 CMG ID number and Gimbal number
SE
     7 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])
SE
     8 Sensor ID number
SE
     8 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
     8 Mounting point body ID, Mounting point node ID
SE
                                                                      2 1
SE
     8 Second mounting point body ID, Second node ID
     8 Input axis unit vector (IA) x,y,z
                                                                      0 0 1
SE
     8 Mounting point Hinge index, Axis index
     8 First focal plane unit vector (Fp1) x,y,z
8 Second focal plane unit vector (Fp2) x,y,z
     8 Sun/Star unit vector (Us) x,y,z
SE
     8 Velocity Aberration Option (Y/N)
SE
     8 Euler Angle Sequence (1-6)
SE
     8 CMG ID number and Gimbal number
SE
    8 Earth pt (rad,lat,lon,ang.rate [m/e, d, d, d/s])
     9 Sensor ID number
     9 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE
     9 Mounting point body ID, Mounting point node ID
SE
     9 Second mounting point body ID, Second node ID
     9 Input axis unit vector (IA) x,y,z
                                                                      0 0 1
SE
     9 Mounting point Hinge index, Axis index
     9 First focal plane unit vector (Fp1) x,y,z
SE
     9 Second focal plane unit vector (Fp2) x,y,z
    9 Sun/Star unit vector (Us) x,y,z
SE
    9 Velocity Aberration Option (Y/N)
     9 Euler Angle Sequence (1-6)
    9 CMG ID number and Gimbal number
    9 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
SE 10 Sensor ID number
SE 10 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                      P3
                                                                      19
SE 10 Mounting point body ID, Mounting point node ID
SE 10 Second mounting point body ID, Second node ID
                                                                      3 1
SE 10 Input axis unit vector (IA) x,y,z
SE 10 Mounting point Hinge index, Axis index
SE 10 First focal plane unit vector (Fp1) x,y,z
SE 10 Second focal plane unit vector (Fp2) x,y,z
SE 10 Sun/Star unit vector (Us) x,y,z
SE 10 Velocity Aberration Option (Y/N)
SE 10 Euler Angle Sequence (1-6)
SE 10 CMG ID number and Gimbal number
SE 10 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
SE 11 Sensor ID number
SE 11 Type(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                      V3
   11 Mounting point body ID, Mounting point node ID
                                                                      1 9
SE 11 Second mounting point body ID, Second node ID
                                                                      3 1
SE 11 Input axis unit vector (IA) x,y,z
   11 Mounting point Hinge index, Axis index
SE 11 First focal plane unit vector (Fp1) x,y,z
SE 11 Second focal plane unit vector (Fp2) x,y,z
SE 11 Sun/Star unit vector (Us) x,y,z
   11 Velocity Aberration Option (Y/N)
SE 11 Euler Angle Sequence (1-6)
SE 11 CMG ID number and Gimbal number
SE 11 Earth pt (rad, lat, lon, ang.rate [m/e, d, d, d/s])
                                                                      12
SE 12 Sensor ID number
SE 12 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
                                                                      FM
   12 Mounting point body ID, Mounting point node ID
                                                                      1 1
SE 12 Second mounting point body ID, Second node ID
SE 12 Input axis unit vector (IA) x,y,z
SE 12 Mounting point Hinge index, Axis index
SE 12 First focal plane unit vector (Fp1) x,y,z
SE 12 Second focal plane unit vector (Fp2) x,y,z
SE 12 Sum/Star unit vector (Us) x,y,z
SE 12 Velocity Aberration Option (Y/N)
```

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SE 13 Mounting point body ID, Mounting point node ID 1 2 SE 13 Second mounting point body ID, Second node ID SE 13 Input axis unit vector (IA) x,y,z 13 Mounting point Hinge index, Axis index SE 13 First focal plane unit vector (Fp1) x,y,z SE 13 Second focal plane unit vector (Fp2) x,y,z SE 13 Sun/Star unit vector (Us) x,y,z
SE 13 Velocity Aberration Option (Y/N) SE 13 Euler Angle Sequence (1-6) SE 13 CMG ID number and Gimbal number SE 13 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 14 SE 14 Sensor ID number SE 14 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM)
SE 14 Mounting point body ID, Mounting point node ID 1 13 SE 14 Second mounting point body ID, Second node ID SE 14 Input axis unit vector (IA) x,y,z 14 Mounting point Hinge index, Axis index SE 14 First focal plane unit vector (Fp1) x,y,z SE 14 Second focal plane unit vector (Fp2) x,y,z SE 14 Sun/Star unit vector (Us) x,y,z SE 14 Velocity Aberration Option (Y/N) SE 14 Euler Angle Sequence (1-6) SE 14 CMG ID number and Gimbal number SE 14 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 15 SE 15 Sensor ID number SE 15 Typ (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) SE 15 Mounting point body ID, Mounting point node ID SE 15 Second mounting point body ID, Second node ID 1 0 0 SE 15 Input axis unit vector (IA) x,y,z 15 Mounting point Hinge index, Axis index SE 15 First focal plane unit vector (Fp1) x,y,z SE 15 Second focal plane unit vector (Fp2) x,y,z SE 15 Sun/Star unit vector (Us) x,y,z SE 15 Velocity Aberration Option (Y/N) SE 15 Euler Angle Sequence (1-6) SE 15 CMG ID number and Gimbal number SE 15 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) 1.6 SE 16 Sensor ID number 16 Typ (G,R,AN, V, P, AC, T, I, SU, ST, L, IM, P3, V3, CR, CT, ET, LV, A3, FM) SE 16 Mounting point body ID, Mounting point node ID SE 16 Second mounting point body ID, Second node ID 1 0 0 16 Input axis unit vector (IA) x,y,z SE 16 Mounting point Hinge index, Axis index SE 16 First focal plane unit vector (Fp1) x,y,z 16 Second focal plane unit vector (Fp2) x,y,z SE 16 Sun/Star unit vector (Us) x,y,z SE 16 Velocity Aberration Option (Y/N) SE 16 Euler Angle Sequence (1-6) 16 CMG ID number and Gimbal number SE 16 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s])

17 SE 17 Sensor ID number SE 17 Typ (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) SE 17 Mounting point body ID, Mounting point node ID 1,1 SE 17 Second mounting point body ID, Second node ID SE 17 Input axis unit vector (IA) x,y,z SE 17 Mounting point Hinge index, Axis index SE 17 First focal plane unit vector (Fp1) x,y,z SE 17 Second focal plane unit vector (Fp2) x,y,z SE 17 Sun/Star unit vector (Us) x,y,z SE 17 Velocity Aberration Option (Y/N) SE 17 Euler Angle Sequence (1-6)

Date: 14 February 2003 TCD20030028A Contract No.: NAS8-00114 SE 17 CMG ID number and Gimbal number SE 17 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) SE 18 Sensor ID number 18 18 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV,A3,FM) FM SE 18 Mounting point body ID, Mounting point node ID 2 1 SE 18 Second mounting point body ID, Second node ID SE 18 Input axis unit vector (IA) x,y,z SE 18 Mounting point Hinge index, Axis index SE 18 First focal plane unit vector (Fp1) x,y,z SE 18 Second focal plane unit vector (Fp2) x,y,z SE 18 Sun/Star unit vector (Us) x,y,z SE 18 Velocity Aberration Option (Y/N) SE 18 Euler Angle Sequence (1-6) SE 18 CMG ID number and Gimbal number SE 18 Earth pt (rad, lat, lon, ang. rate [m/e, d, d, d/s]) ACTR 1 Actuator ID number 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) AC AC 1 Actuator location; Node or Hinge (N or H) 1 5 AC 1 Mounting point body ID number, node ID number 1 Second mounting point body ID, second node ID 1 Output axis unit vector x,y,z 1 0 0 AC AC 1 Mounting point Hinge index, Axis index AC 1 Rotor spin axis unit vector x,y,z 1 Initial rotor momentum, H AC 1 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) AC 1 Outer gimbal axis unit vector x,y,z 1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC 1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) AC AC 1 Inner gimbal axis unit vector x,y,z 1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC AC 1 Initial length and rate, y(to) and ydot(to) AC 1 Constants; K1 or wo, n or zeta, Kg, Jm 1 Non-linearities; TLim, Tco, Dz AC 2 AC 2 Actuator ID number 2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) J AC 2 Actuator location; Node or Hinge (N or H) AC 2 Mounting point body ID number, node ID number 2 Second mounting point body ID, second node ID 1 6 AC -1 0 0 2 Output axis unit vector x,y,z AC 2 Mounting point Hinge index, Axis index 2 Rotor spin axis unit vector x,y,z 2 Initial rotor momentum, H 2 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) AC 2 Outer gimbal axis unit vector x,y,z 2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) AC 2 Inner gimbal axis unit vector x,y,z AC 2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 2 Initial length and rate, y(to) and ydot(to) AC AC 2 Constants; K1 or wo, n or zeta, Kg, Jm 2 Non-linearities; TLim, Tco, Dz J 1 7

|    | _ | ,,,,,                                                              |
|----|---|--------------------------------------------------------------------|
| AC | 3 | Actuator ID number                                                 |
| AC | 3 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                |
| AC | 3 | Actuator location; Node or Hinge (N or H)                          |
| AC | 3 | Mounting point body ID number, node ID number                      |
| AC | 3 | Second mounting point body ID, second node ID                      |
| AC | 3 | Output axis unit vector x,y,z                                      |
| AC | 3 | Mounting point Hinge index, Axis index                             |
| AC | 3 | Rotor spin axis unit vector x,y,z                                  |
| AC | 3 | Initial rotor momentum, H                                          |
| AC | 3 | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)            |
| ДC | 3 | Outer gimbal axis unit vector x, y, z                              |
| AC | 3 | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                 |
| AC | 3 | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre> |
|    |   |                                                                    |
|    |   |                                                                    |

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| AC       | 3 Inner gimbal axis unit vector x,y,z                                                              |        |
|----------|----------------------------------------------------------------------------------------------------|--------|
| AC       | <pre>3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                     |        |
| AC       | <pre>3 Initial length and rate, y(to) and ydot(to)</pre>                                           |        |
| AC       | 3 Constants; K1 or wo, n or zeta, Kg, Jm                                                           |        |
| AC       | 3 Non-linearities; TLim, Tco, Dz                                                                   |        |
| AC       | 4 Actuator ID number                                                                               | 4      |
| AC       | 4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                              | J      |
| AC       | 4 Actuator location; Node or Hinge (N or H)                                                        |        |
| AC       | 4 Mounting point body ID number, node ID number                                                    | 1 8    |
| AC       | 4 Second mounting point body ID, second node ID                                                    |        |
| AC       | 4 Output axis unit vector x,y,z                                                                    | -1 0 0 |
| AC       | 4 Mounting point Hinge index, Axis index                                                           |        |
| AC       | 4 Rotor spin axis unit vector x,y,z                                                                |        |
| AC       | 4 Initial rotor momentum, H                                                                        |        |
| AC<br>AC | 4 Outer gimbal- angle(deg), inertia, friction(D, S, B, N) 4 Outer gimbal axis unit vector x, y, z  |        |
| AC       | 4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                               |        |
| AC       | 4 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                          |        |
| AC       | 4 Inner gimbal axis unit vector x,y,z                                                              |        |
| AC       | 4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                |        |
| AC       | 4 Initial length and rate, y(to) and ydot(to)                                                      |        |
| AC       | 4 Constants; K1 or wo, n or zeta, Kg, Jm                                                           |        |
| AC       | 4 Non-linearities; TLim, Tco, Dz                                                                   |        |
|          |                                                                                                    | -      |
| AC       | 5 Actuator ID number                                                                               | 5      |
| AC       | 5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 5 Actuator location; Node or Hinge (N or H)                  | J      |
| AC<br>AC | 5 Mounting point body ID number, node ID number                                                    | 1 8    |
| AC       | 5 Second mounting point body ID, second node ID                                                    | 1 0    |
| AC       | 5 Output axis unit vector x,y,z                                                                    | 0 1 0  |
| AC       | 5 Mounting point Hinge index, Axis index                                                           |        |
| AC       | 5 Rotor spin axis unit vector x,y,z                                                                |        |
| AC       | 5 Initial rotor momentum, H                                                                        |        |
| AC       | 5 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                             |        |
| AC       | 5 Outer gimbal axis unit vector x,y,z                                                              |        |
| AC       | <pre>5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                    |        |
| AC       | 5 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                             |        |
| AC       | 5 Inner gimbal axis unit vector x,y,z                                                              |        |
| AC       | 5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                |        |
| AC       | 5 Initial length and rate, y(to) and ydot(to)                                                      |        |
| AC<br>AC | 5 Constants; K1 or wo, n or zeta, Kg, Jm<br>5 Non-linearities; TLim, Tco, Dz                       |        |
| AC       | J Nou-linearities; Illim, 100, 02                                                                  |        |
| AC       | 6 Actuator ID number                                                                               | 6      |
| AC       | 6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                              | J      |
| AC       | 6 Actuator location; Node or Hinge (N or H)                                                        | 1 8    |
| AC<br>AC | 6 Mounting point body ID number, node ID number<br>6 Second mounting point body ID, second node ID | 1.0    |
| AC       | 6 Output axis unit vector x,y,z                                                                    | 0 -1 0 |
| AC       | 6 Mounting point Hinge index, Axis index                                                           |        |
| AC       | 6 Rotor spin axis unit vector x,y,z                                                                |        |
| AC       | 6 Initial rotor momentum, H                                                                        |        |
| AC       | <pre>6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                    |        |
| AC       | 6 Outer gimbal axis unit vector x,y,z                                                              |        |
| AC       | 6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                               |        |
| AC       | 6 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                             |        |
| AC       | 6 Inner gimbal axis unit vector x,y,z                                                              |        |
| AC       | 6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 6 Initial length and rate w(ta) and wdat/ta)   |        |
| AC<br>AC | 6 Initial length and rate, y(to) and ydot(to) 6 Constants; K1 or wo, n or zeta, Kg, Jm             |        |
| AC       | 6 Non-linearities; TLim, Tco, Dz                                                                   |        |
|          | v area analog about a cot ou                                                                       |        |
| AC       | 7 Actuator ID number                                                                               | 7      |
| AC       | 7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                              | J      |
| AC       | 7 Actuator location; Node or Hinge (N or H)                                                        |        |
| AC       | 7 Mounting point body ID number, node ID number                                                    | 1 5    |
| AC       | 7 Second mounting point body ID, second node ID                                                    | _      |
| AC       | 7 Output axis unit vector x,y,z                                                                    | 0 1 0  |
| AC       | 7 Mounting point Hinge index, Axis index                                                           |        |
| AC       | 7 Rotor spin axis unit vector x,y,z                                                                |        |
|          |                                                                                                    |        |

Contract No.: NAS8-00114 7 Initial rotor momentum, H 7 Outer gimbal-angle(deg), inertia, friction(D,S,B,N) 7 Outer gimbal axis unit vector x,y,z AC 7 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) 7 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) AC AC 7 Inner gimbal axis unit vector x,y,z 7 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 7 Initial length and rate, y(to) and ydot(to) AC 7 Constants; K1 or wo, n or zeta, Kg, Jm AC 7 Non-linearities; TLim, Tco, Dz 8 AC 8 Actuator ID number AC 8 Type (J, H, MO, T, B, MA, SG, DG, W, L, M1-M7) J 8 Actuator location; Node or Hinge (N or H) AC 1 5 AC 8 Mounting point body ID number, node ID number AC 8 Second mounting point body ID, second node ID 0 -1 0 AC 8 Output axis unit vector x,y,z AC 8 Mounting point Hinge index, Axis index AC 8 Rotor spin axis unit vector x,y,z AC 8 Initial rotor momentum, H 8 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) AC 8 Outer gimbal axis unit vector x,y,z 8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) AC AC AC 8 Inner gimbal axis unit vector x,y,z 8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC AC 8 Initial length and rate, y(to) and ydot(to) AC 8 Constants; K1 or wo, n or zeta, Kg, Jm 8 Non-linearities; TLim, Tco, Dz AC 9 Actuator ID number 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) AC AC 9 Actuator location; Node or Hinge (N or H) 9 Mounting point body ID number, node ID number 9 Second mounting point body ID, second node ID AC 1 7 AC 9 Output axis unit vector x,y,z 0 1 0 AC 9 Mounting point Hinge index, Axis index AC AC 9 Rotor spin axis unit vector x,y,z AC 9 Initial rotor momentum, H 9 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) AC AC 9 Outer gimbal axis unit vector x,y,z 9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC 9 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) AC AC 9 Inner gimbal axis unit vector x,y,z 9 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC AC 9 Initial length and rate, y(to) and ydot(to) AC 9 Constants; K1 or wo, n or zeta, Kg, Jm AC 9 Non-linearities; TLim, Tco, Dz AC 10 Actuator ID number 10 10 Type (J, H, MO, T, B, MA, SG, DG, W, L, M1-M7) J AC 10 Actuator location; Node or Hinge (N or H) AC 10 Mounting point body ID number, node ID number 1 7 AC 10 Second mounting point body ID, second node ID 10 Output axis unit vector x,y,z 0 -1 0 AC 10 Mounting point Hinge index, Axis index AC 10 Rotor spin axis unit vector x,y,z 10 Initial rotor momentum, H 10 Outer gimbal- angle(deg), inertia, friction(D, S, B, N) 10 Outer gimbal axis unit vector x,y,z 10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) AC 10 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 10 Inner gimbal axis unit vector x,y,z 10 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k) AC 10 Initial length and rate, y(to) and ydot(to) AC 10 Constants; K1 or wo, n or zeta, Kg, Jm

AC 10 Non-linearities; TLim, Tco, Dz

AC 11 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) AC 11 Actuator location; Node or Hinge (N or H)

11 Actuator ID number

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| AC                                                                              | 11                                                                                                                                           | Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 6                            |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| AC                                                                              | 11                                                                                                                                           | Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| AC                                                                              | 11                                                                                                                                           | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0 1 0                          |
| AC                                                                              | 11                                                                                                                                           | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| AC                                                                              | 11                                                                                                                                           | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                |
| AC                                                                              | 11                                                                                                                                           | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| AC                                                                              | 11                                                                                                                                           | Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| AC                                                                              | 11                                                                                                                                           | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| AC                                                                              | 11                                                                                                                                           | Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                |
| AC                                                                              |                                                                                                                                              | <pre>Inner gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| AC                                                                              | 11                                                                                                                                           | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| AC                                                                              |                                                                                                                                              | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| AC                                                                              |                                                                                                                                              | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |
| AC                                                                              |                                                                                                                                              | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| AC                                                                              | 11                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |
|                                                                                 |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 12                             |
| AC                                                                              |                                                                                                                                              | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 12<br>Ј                        |
| AC                                                                              |                                                                                                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Ü                              |
| AC                                                                              |                                                                                                                                              | Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 6                            |
| AC                                                                              |                                                                                                                                              | Mounting point body ID number, node ID number<br>Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1 0                            |
| AC<br>AC                                                                        |                                                                                                                                              | Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0 -1 0                         |
| AC                                                                              |                                                                                                                                              | Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | V # 5                          |
| AC                                                                              |                                                                                                                                              | Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                |
| AC                                                                              |                                                                                                                                              | Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| AC                                                                              |                                                                                                                                              | Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                |
| AC                                                                              |                                                                                                                                              | Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| AC                                                                              |                                                                                                                                              | Out gim fric (Tfi, Tgfo, GAM)/(Tfi, M, D, Kf)/(m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |
| AC                                                                              |                                                                                                                                              | <pre>Inner gimbal- angle(deg), inertia, friction(D, S, B, N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                |
| AC                                                                              |                                                                                                                                              | Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| AC                                                                              |                                                                                                                                              | In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| AC                                                                              |                                                                                                                                              | Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |
| AC                                                                              |                                                                                                                                              | Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| AC                                                                              | 12                                                                                                                                           | Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |
|                                                                                 |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |
|                                                                                 | 4 2                                                                                                                                          | Astronom TD number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                |
| AC                                                                              |                                                                                                                                              | Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 13                             |
| AC                                                                              | 13                                                                                                                                           | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | J                              |
| AC<br>AC                                                                        | 13<br>13                                                                                                                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J                              |
| AC<br>AC<br>AC                                                                  | 13<br>13<br>13                                                                                                                               | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |
| AC<br>AC<br>AC<br>AC                                                            | 13<br>13<br>13<br>13                                                                                                                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC                                                      | 13<br>13<br>13<br>13                                                                                                                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J                              |
| AC<br>AC<br>AC<br>AC<br>AC                                                      | 13<br>13<br>13<br>13<br>13                                                                                                                   | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 13<br>13<br>13<br>13<br>13<br>13                                                                                                             | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 13<br>13<br>13<br>13<br>13<br>13<br>13                                                                                                       | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                    | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                                                 | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                    | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                                           | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                    | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                               | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                               | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13                                                                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>1 7                       |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg), inertia, friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | J<br>1 7                       |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC      | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>1 7<br>0 0 1              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | J<br>1 7<br>0 0 1              |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | J<br>1 7<br>0 0 1              |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J<br>1 7<br>0 0 1              |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>1 7<br>0 0 1              |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                 | 1 7<br>0 0 1<br>14<br>J<br>1 5 |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>14<br>14                                     | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                      | J<br>1 7<br>0 0 1              |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>14<br>14<br>14                               | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                               | 1 7<br>0 0 1<br>14<br>J<br>1 5 |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>14<br>14<br>14<br>14                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                             | 1 7<br>0 0 1<br>14<br>J<br>1 5 |
| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>14<br>14<br>14<br>14<br>14<br>14<br>14<br>14                         | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H                                                                                                                                                                                                                                | 1 7<br>0 0 1<br>14<br>J<br>1 5 |
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| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,K) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z                                                                                      | 1 7<br>0 0 1<br>14<br>J<br>1 5 |
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| AC A                                        | 13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>13<br>1                                                              | Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal axis unit vector x,y,z Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Initial length and rate, y(to) and ydot(to) Constants; K1 or wo, n or zeta, Kg, Jm Non-linearities; TLim, Tco, Dz  Actuator ID number Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) Actuator location; Node or Hinge (N or H) Mounting point body ID number, node ID number Second mounting point body ID, second node ID Output axis unit vector x,y,z Mounting point Hinge index, Axis index Rotor spin axis unit vector x,y,z Initial rotor momentum, H Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Outer gimbal- angle(deg),inertia,friction(D,S,B,N) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) Inner gimbal axis unit vector x,y,z In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) | 1 7<br>0 0 1<br>14<br>J<br>1 5 |

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| AC       | 2 14 Non-linearities; TLim, Tco, Dz                                                       |        |
|----------|-------------------------------------------------------------------------------------------|--------|
| AC       | 2 15 Actuator ID number                                                                   | 15     |
| AC       | 15 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                    | J      |
| AC       |                                                                                           |        |
| AC       |                                                                                           | 1 8    |
| AC       |                                                                                           | 0.0.1  |
| AC<br>AC |                                                                                           | 0 0 1  |
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| AC       | 16 Actuator ID number                                                                     | 16     |
| AC       |                                                                                           | J      |
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| AC       | - · · · · · · · · · · · · · · · · · · ·                                                   | k)     |
| AC       |                                                                                           |        |
| AC       | 16 Constants; K1 or wo, n or zeta, Kg, Jm                                                 |        |
| AC       | 16 Non-linearities; TLim, Tco, Dz                                                         |        |
| AC       | 17 Actuator ID number                                                                     | 17     |
| AC       |                                                                                           | J      |
| AC       |                                                                                           | 1.2    |
| AC       |                                                                                           | 1 2    |
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| AC       |                                                                                           | k)     |
| AC       |                                                                                           |        |
| AC       |                                                                                           |        |
| AC       | 17 Non-linearities; TLim, Tco, Dz                                                         |        |
| AC       |                                                                                           | 18     |
| AC       |                                                                                           | J      |
| AC       |                                                                                           | 1 2    |
| AC<br>AC |                                                                                           | 1.4    |
| AC       |                                                                                           | 0 1 0  |
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| AC<br>AC | 18 Outer gimbal axis unit vector x,y,z 18 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B | ·      |
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| AC<br>AC                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| ΔC                                                                              | 18 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              | 18 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |
| AÇ                                                                              | 18 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |
| AC                                                                              | 18 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |
|                                                                                 | To how Immediately, Ibin, 100, bi                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10                     |
| AC                                                                              | 19 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 19                     |
| AC                                                                              | 19 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | J                      |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              | · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 2                    |
|                                                                                 | •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1 2                    |
| AC                                                                              | 19 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| AC                                                                              | 19 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0 0 1                  |
| AC                                                                              | 19 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |
| AC                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
|                                                                                 | = · · · · · · · · · · · · · · · · · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |
| AC                                                                              | 19 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |
| AC                                                                              | <pre>19 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| AC                                                                              | 19 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                        |
| AC                                                                              | 19 Out gim fric (Tfi, Tgfo, GAM)/(Tfi, M, D, Kf)/(m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |
|                                                                                 | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |
| AC                                                                              | <pre>19 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| AC                                                                              | 19 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                        |
| AC                                                                              | 19 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| AC                                                                              | 19 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              | 19 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |
| AC                                                                              | 19 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| 30                                                                              | 20 Agreement TD number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20                     |
| AC                                                                              | 20 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |
| AC                                                                              | 20 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | MO                     |
| AC                                                                              | 20 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |
| AC                                                                              | 20 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1 2                    |
| AC                                                                              | 20 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 0 0                  |
| AC                                                                              | 20 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 100                    |
| AC                                                                              | 20 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |
| AC                                                                              | 20 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |
| AC                                                                              | 20 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              | <pre>20 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |
| AC                                                                              | 20 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                        |
| AC                                                                              | 20 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC                                                                              | 20 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |
| AC<br>AC                                                                        | 20 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 20 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |
|                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |
| AC<br>AC                                                                        | <pre>20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                        |
| AC<br>AC<br>AC                                                                  | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |
| AC<br>AC<br>AC<br>AC                                                            | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |
| AC<br>AC<br>AC                                                                  | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |
| AC<br>AC<br>AC<br>AC                                                            | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |
| AC<br>AC<br>AC<br>AC                                                            | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 21                     |
| AC<br>AC<br>AC<br>AC<br>AC                                                      | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz 21 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 21<br>MO               |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | МО                     |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                                | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                          | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | МО                     |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                              | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC            | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC      | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC      | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC      | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 22 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | MO<br>1 2              |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                          | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Ingim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                   | MO<br>1 2              |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                  | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Ingim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                   | MO<br>1 2              |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                  | MO<br>1 2              |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>A | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                  | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Inner gimbal axis unit vector x,y,z 24 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 25 Inner gimbal axis unit vector x,y,z 26 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 27 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis Unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Actuator ID number | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz  22 Actuator ID number 22 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                            | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Inner gimbal axis unit vector x,y,z 24 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 25 Inner gimbal axis unit vector x,y,z 26 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 27 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis Unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Actuator ID number | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz  22 Actuator ID number 22 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 22 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                     | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 22 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz  26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number                                                                                                                        | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 22 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz  26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID                                                                       | MO 1 2 0 1 0 22 MO 1 2 |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 21 Outer gimbal angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz  22 Actuator ID number 23 Actuator ID number 24 Actuator location; Node or Hinge (N or H) 25 Mounting point body ID number, node ID number 26 Second mounting point body ID, second node ID 27 Output axis unit vector x,y,z                                                        | MO<br>1 2<br>0 1 0     |
| AC A                                        | 20 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  21 Actuator ID number 21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 21 Actuator location; Node or Hinge (N or H) 21 Mounting point body ID number, node ID number 21 Second mounting point body ID, second node ID 21 Output axis unit vector x,y,z 21 Mounting point Hinge index, Axis index 21 Rotor spin axis unit vector x,y,z 22 Initial rotor momentum, H 21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 21 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 21 Inner gimbal axis unit vector x,y,z 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm 25 Non-linearities; TLim, Tco, Dz  26 Actuator ID number 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID                                                                       | MO 1 2 0 1 0 22 MO 1 2 |

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| AC       | 22 Rotor spin axis unit vector x,y,z                                                                        |         |
|----------|-------------------------------------------------------------------------------------------------------------|---------|
| AC       | 22 Initial rotor momentum, H                                                                                |         |
| AC       | 22 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                       |         |
| AC<br>AC | 22 Outer gimbal axis unit vector x,y,z 22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                |         |
| AC       | 22 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                  |         |
| AC       | 22 Inner gimbal axis unit vector x,y,z                                                                      |         |
| AC       | 22 In gim fric (Tfi, Tgfo, GAM)/(Tfi, M, D, Kf)/(m, M, B, k)                                                |         |
| AC       | 22 Initial length and rate, y(to) and ydot(to)                                                              |         |
| AC       | 22 Constants; K1 or wo, n or zeta, Kg, Jm                                                                   |         |
| AC       | 22 Non-linearities; TLim, Tco, Dz                                                                           |         |
| AC       | 23 Actuator ID number                                                                                       | 23      |
| AC       | 23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                      | MA      |
| AC       | 23 Actuator location; Node or Hinge (N or H)                                                                |         |
| AC       | 23 Mounting point body ID number, node ID number                                                            | 1 2     |
| AC<br>AC | 23 Second mounting point body ID, second node ID 23 Output axis unit vector x,y,z                           | 1 0 0   |
| AC       | 23 Mounting point Hinge index, Axis index                                                                   | 100     |
| AC       | 23 Rotor spin axis unit vector x,y,z                                                                        |         |
| AC       | 23 Initial rotor momentum, H                                                                                |         |
| AC       | 23 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                  |         |
| AC       | 23 Outer gimbal axis unit vector x,y,z                                                                      |         |
| AC<br>AC | 23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) |         |
| AC       | 23 Inner gimbal axis unit vector x,y,z                                                                      |         |
| AC       | 23 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                        |         |
| AC       | 23 Initial length and rate, y(to) and ydot(to)                                                              |         |
| AC       | 23 Constants; K1 or wo, n or zeta, Kg, Jm                                                                   |         |
| AC       | 23 Non-linearities; TLim, Tco, Dz                                                                           |         |
| AC       | 24 Actuator ID number                                                                                       | 24      |
| AC       | 24 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                      | MA      |
| AC       | 24 Actuator location; Node or Hinge (N or H)                                                                |         |
| AC       | 24 Mounting point body ID number, node ID number                                                            | 1 2     |
| AC       | 24 Second mounting point body ID, second node ID                                                            |         |
| AC       | 24 Output axis unit vector x,y,z                                                                            | 0 1 0   |
| AC<br>AC | 24 Mounting point Hinge index, Axis index 24 Rotor spin axis unit vector x,y,z                              |         |
| AC       | 24 Initial rotor momentum, H                                                                                |         |
| AC       | 24 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                  |         |
| AC       | 24 Outer gimbal axis unit vector x,y,z                                                                      |         |
| AC       | 24 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                       |         |
| AC<br>AC | 24 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 24 Inner gimbal axis unit vector x,y,z                |         |
| AC       | 24 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                        |         |
| AC       | 24 Initial length and rate, y(to) and ydot(to)                                                              |         |
| AC       | 24 Constants; K1 or wo, n or zeta, Kg, Jm                                                                   |         |
| AC       | 24 Non-linearities; TLim, Tco, Dz                                                                           |         |
| AC       | 25 Actuator ID number                                                                                       | 25      |
| AC       | 25 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                      | MA      |
| AC       | 25 Actuator location; Node or Hinge (N or H)                                                                |         |
| AC       | 25 Mounting point body ID number, node ID number                                                            | 1 2     |
| AC       | 25 Second mounting point body ID, second node ID                                                            | 0 0 1   |
| AC<br>AC | 25 Output axis unit vector x,y,z 25 Mounting point Hinge index, Axis index                                  | 0 0 1   |
| AC       | 25 Rotor spin axis unit vector x,y,z                                                                        |         |
| AC       | 25 Initial rotor momentum, H                                                                                |         |
| AC       | 25 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)                                                  |         |
| AC       | 25 Outer gimbal axis unit vector x,y,z                                                                      |         |
| AC       | 25 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                       |         |
| AC<br>AC | 25 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 25 Inner gimbal axis unit vector x,y,z              |         |
| AC       | 25 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                        |         |
| AC       | 25 Initial length and rate, y(to) and ydot(to)                                                              |         |
| AC       | 25 Constants; K1 or wo, n or zeta, Kg, Jm                                                                   |         |
| AC       | 25 Non-linearities; TLim, Tco, Dz                                                                           |         |
| 20       | 26 Actuator ID number                                                                                       | 26      |
| AC<br>AC | 26 Actuator ID number<br>26 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                             | 26<br>J |
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| AC                                                                         | 26 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                      |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| AC                                                                         | 26 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3 2                                  |
| AC                                                                         | 26 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |
| AC                                                                         | 26 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100                                  |
| AC                                                                         | 26 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |
| AC<br>AC                                                                   | 26 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC                                                                         | 26 Initial rotor momentum, H 26 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                      |
| AC                                                                         | 26 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |
| AC                                                                         | 26 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |
| AC                                                                         | 26 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                      |
| AC                                                                         | 26 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |
| AC                                                                         | 26 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC                                                                         | 26 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |
| AC                                                                         | 26 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |
| AC                                                                         | 26 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |
| AC                                                                         | 27 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 27                                   |
| AC                                                                         | 27 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J.                                   |
| AC                                                                         | 27 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | _                                    |
| AC                                                                         | 27 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3 2                                  |
| AC                                                                         | 27 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |
| AC                                                                         | 27 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0 1 0                                |
| AC                                                                         | 27 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |
| AC                                                                         | 27 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC                                                                         | 27 Initial rotor momentum, H 27 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC<br>AC                                                                   | 27 Outer gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |
| AC                                                                         | 27 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |
| AC                                                                         | 27 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                      |
| AC                                                                         | 27 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |
| AC                                                                         | 27 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC                                                                         | 27 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |
| AC                                                                         | 27 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |
| AC                                                                         | 27 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |
|                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                      |
| AC                                                                         | 28 Actuator ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 28                                   |
| AC<br>AC                                                                   | 28 Actuator ID number 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 28<br>J                              |
|                                                                            | 28 Actuator ID number 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |
| AC                                                                         | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |
| AC<br>AC<br>AC<br>AC                                                       | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC                                                 | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J                                    |
| AC<br>AC<br>AC<br>AC<br>AC                                                 | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                           | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                                     | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC                                           | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                               | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                         | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | J<br>3 2                             |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 30 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 31 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>3 2                             |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>3 2                             |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg), inertia, friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 30 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 31 Initial length and rate, y(to) and ydot(to)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>3 2                             |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 23 Initial length and rate, y(to) and ydot(to) 24 Constants; K1 or wo, n or zeta, Kg, Jm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J<br>3 2                             |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 28 Constants; K1 or wo, n or zeta, Kg, Jm 28 Non-linearities; TLim, Tco, Dz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  CONTROLLER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J 3 2 0 0 1                          |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz  CONTROLLER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>3 2                             |
| AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC<br>AC | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  CONTROLLER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J 3 2 0 0 1                          |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 29 Rotor spin axis unit vector x,y,z 20 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Initial length and rate, y(to) and ydot(to) 23 Constants; K1 or wo, n or zeta, Kg, Jm 24 Non-linearities; TLim, Tco, Dz  CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | J 2 0 0 1                            |
| AC A                                   | <pre>28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 28 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 28 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 28 Constants; K1 or wo, n or zeta, Kg, Jm 28 Non-linearities; TLim, Tco, Dz 28 CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | J<br>3 2<br>0 0 1<br>1<br>UD<br>0.10 |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 29 Outer gimbal axis unit vector x,y,z 20 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Inner gimbal axis unit vector x,y,z 21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Initial length and rate, y(to) and ydot(to) 23 Constants; K1 or wo, n or zeta, Kg, Jm 24 Non-linearities; TLim, Tco, Dz 25 CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | J<br>3 2<br>0 0 1<br>1<br>UD<br>0.10 |
| AC A                                   | <pre>28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 29 Mounting point Hinge index, Axis index 20 Rotor spin axis unit vector x,y,z 21 Initial rotor momentum, H 22 Outer gimbal axis unit vector x,y,z 23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 26 Inner gimbal axis unit vector x,y,z 27 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 22 Non-linearities; TLim, Tco, Dz 23 CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | J 3 2 0 0 1  1 UD 0.10 21 16         |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 29 Inner gimbal axis unit vector x,y,z 20 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz 21 CONTROLLER 22 CONTROLLER 3 Controller ID number 3 Controller type (CB,CM,DB,DM,UC,UD) 4 Sample time (sec) 5 Number of inputs, Number of outputs 6 Number of states 7 Output No., Input type (I,S,T), Input ID, Gain 7 Controller ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | J 3 2 0 0 1  1 UD 0.10 21 16         |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain 2 Controller ID number 2 Controller ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J 3 2 0 0 1  1 UD 0.10 21 16         |
| AC A                                   | <pre>28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 29 Rotor spin axis unit vector x,y,z 20 Initial rotor momentum, H 20 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 20 Outer gimbal- axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 21 Non-linearities; TLim, Tco, Dz 22 CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain 2 Controller ID number 2 Controller ID number 3 Controller ID number 4 Controller ID number 5 Controller ID number 6 Controller ID number 7 Controller ID number 8 Controller ID number 9 Controller ID number 1 Controller ID number 1 Controller ID number 2 Controller ID number 3 Controller ID number 4 Controller ID number 5 Controller ID number 6 Controller ID number 7 Controller ID number 8 Controller ID number 9 Controller ID number</pre> | J 3 2 0 0 1  1 UD 0.10 21 16         |
| AC A                                   | 28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 28 Rotor spin axis unit vector x,y,z 28 Initial rotor momentum, H 28 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Outer gimbal axis unit vector x,y,z 29 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 28 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 29 Initial length and rate, y(to) and ydot(to) 20 Constants; K1 or wo, n or zeta, Kg, Jm 20 Non-linearities; TLim, Tco, Dz  CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain 2 Controller ID number 2 Controller ID number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | J 3 2 0 0 1  1 UD 0.10 21 16         |
| AC A                                   | <pre>28 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) 28 Actuator location; Node or Hinge (N or H) 28 Mounting point body ID number, node ID number 28 Second mounting point body ID, second node ID 28 Output axis unit vector x,y,z 28 Mounting point Hinge index, Axis index 29 Rotor spin axis unit vector x,y,z 20 Initial rotor momentum, H 20 Outer gimbal- angle(deg),inertia,friction(D,S,B,N) 20 Outer gimbal axis unit vector x,y,z 21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 22 Inner gimbal- angle(deg),inertia,friction(D,S,B,N) 28 Inner gimbal axis unit vector x,y,z 29 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k) 20 Initial length and rate, y(to) and ydot(to) 21 Constants; K1 or wo, n or zeta, Kg, Jm 22 Non-linearities; TLim, Tco, Dz 23 CONTROLLER  1 Controller ID number 1 Controller type (CB,CM,DB,DM,UC,UD) 1 Sample time (sec) 1 Number of inputs, Number of outputs 1 Number of states 1 Output No., Input type (I,S,T), Input ID, Gain 2 Controller ID number 2 Controller ID number 2 Controller type (CB,CM,DB,DM,UC,UD) 2 Sample time (sec) 2 Number of inputs, Number of outputs</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J 3 2 0 0 1  1 UD 0.10 21 16         |

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#### INTERCONNECT

| IN           | 1  | Interconnect ID number                 |                |    | 1        |     |
|--------------|----|----------------------------------------|----------------|----|----------|-----|
| IN           |    | Source type(S,C, or F), Source I       | D.Source row   | #  | c 1      | 1   |
| IN           |    | Destination type(A or C), Dest I       |                |    | A 1      |     |
| IN           |    | Gain                                   |                |    | 1        |     |
|              | _  |                                        |                |    | -        |     |
| IN           | 2  | Interconnect ID number                 |                |    | 2        |     |
| IN           |    | Source type(S,C, or F), Source I       | D.Source row   | #  | C 1      | 2   |
| IN           |    | Destination type (A or C), Dest I      |                |    | A 2      | 1   |
| IN           |    | Gain                                   | <b>,</b>       |    | 1        |     |
|              |    |                                        |                |    |          |     |
| IN           | 3  | Interconnect ID number                 |                |    | 3        |     |
| IN           | 3  | Source type(S,C, or F), Source I       | D, Source row  | #  | C 1      | 3   |
| IN           | 3  | Destination type(A or C), Dest I       | D,Dest row #   |    | A 3      | 1   |
| IN           | 3  | Gain                                   |                |    | 1        |     |
|              |    |                                        |                |    |          |     |
| IN           |    | Interconnect ID number                 |                |    | 4        |     |
| IN           |    | Source type(S,C, or F), Source I       |                | #  | C 1      |     |
| IN           |    | Destination type(A or C), Dest I       | D,Dest row #   |    | A 4      | 1   |
| IN           | 4  | Gain                                   |                |    | 1        |     |
| ***          | _  | Tabana and Thomas                      |                |    | _        |     |
| IN           |    | Interconnect ID number                 | TD Courses was | ш  | 5<br>C 1 | =   |
| IN           |    | Source type(S,C, or F), Source I       |                | #  | A 5      |     |
| IN           |    | Destination type(A or C), Dest I Gain  | .D,Desc row #  |    | A 5      | _   |
| IN           | 3  | Gain                                   |                |    | 1        |     |
| IN           | 6  | Interconnect ID number                 |                |    | 6        |     |
| IN           |    | Source type(S,C, or F), Source I       | D Source row   | #  | C 1      | 6   |
| IN           |    | Destination type(A or C), Dest I       |                | π  | A 6      |     |
| IN           |    | Gain                                   | .D, Desc 10W # |    | 1        | -   |
|              | ٠  | ouz.                                   |                |    | -        |     |
| IN           | 7  | Interconnect ID number                 |                |    | 7        |     |
| IN           |    | Source type(S,C, or F), Source I       | D, Source row  | #  | C 1      | 7   |
| IN           |    | Destination type (A or C), Dest I      |                |    | A 7      | 1   |
| IN           |    | Gain                                   |                |    | 1        |     |
|              |    |                                        |                |    |          |     |
| IN           | 8  | Interconnect ID number                 |                |    | 8        |     |
| IN           | 8  | Source type(S,C, or F), Source I       | D, Source row  | #  | C 1      |     |
| IN           |    | Destination type(A or C), Dest I       | D,Dest row #   |    | A 8      | 1   |
| IN           | 8  | Gain                                   |                |    | 1        |     |
| <b>T</b> > 7 | _  | T                                      |                |    | •        |     |
| IN           |    | Interconnect ID number                 | .D. Garrage    | ш  | 9<br>C 1 | 0   |
| IN<br>IN     |    | Source type(S,C, or F), Source I       |                | #  | A 9      |     |
| IN           |    | Destination type (A or C), Dest I Gain | .D,Dest IOW #  |    | î        | -   |
|              | -  | <b></b>                                |                |    |          |     |
| IN           | 10 | Interconnect ID number                 |                |    | 10       |     |
| IN           |    | Source type(S,C, or F), Source I       | D, Source row  | #  | C 1      | 10  |
| IN           | 10 | Destination type (A or C), Dest I      | D,Dest row #   |    | A 10     | 1   |
| IN           | 10 | Gain                                   |                |    | 1        |     |
|              |    |                                        |                |    |          |     |
| IN           |    | Interconnect ID number                 |                |    | 11       |     |
| IN           | 11 | Source type(S,C, or F), Source I       | D,Source row   | #  | C 1      |     |
| IN           |    | Destination type(A or C),Dest I        | D,Dest row #   |    | A 1:     | 1 1 |
| IN           | 11 | Gain                                   |                |    | 1        |     |
|              |    |                                        |                |    |          |     |
| IN           |    | Interconnect ID number                 | D. G           | ш  | 12       | 10  |
| IN           |    | Source type(S,C, or F), Source I       |                | ₹  | C 1      |     |
| IN           |    | Destination type(A or C), Dest I       | D,Dest row #   |    | A 12     | . I |
| IN           | 14 | Gain                                   |                |    | 1        |     |
| IN           | 13 | Interconnect ID number                 |                |    | 13       |     |
| IN           |    | Source type(S,C, or F), Source I       | D. Source row  | #  | C 1      | 13  |
| IN           |    | Destination type (A or C), Dest I      |                | •• | A 13     |     |
| IN           |    | Gain                                   | _,             |    | 1        |     |
| •            |    |                                        |                |    |          |     |
| IN           | 14 | Interconnect ID number                 |                |    | 14       |     |
| IN           |    | Source type(S,C, or F), Source I       | D, Source row  | #  | C 1      | 14  |
|              |    |                                        |                |    |          |     |

| IN<br>IN |                                            | : row #    | A 14 1<br>1    |
|----------|--------------------------------------------|------------|----------------|
| IN       | 15 Interconnect ID number                  |            | 15             |
| IN       |                                            | ce row #   | C 1 15         |
| IN       |                                            |            | A 15 1         |
| IN       |                                            | . 2011     | 1              |
| IN<br>IN |                                            | rce row #  | 16<br>C 1 16   |
| IN       |                                            |            | A 16 1         |
| IN       |                                            | . <b>-</b> | 1              |
| IN       |                                            |            | 26             |
| IN       |                                            |            | S 1 1<br>C 1 1 |
| IN<br>IN | • • • • • • • • • • • • • • • • • • • •    | LOW #      | 1              |
|          |                                            |            | _              |
| IN       |                                            |            | 27<br>\$ 2 1   |
| IN<br>IN |                                            |            | C 1 2          |
| IN       | '                                          | , 10w #    | 1              |
|          |                                            |            |                |
| IN       |                                            | rgo work # | 28<br>S 3 1    |
| IN       |                                            |            | C 1 3          |
| IN<br>IN |                                            | . 10w #    | 1              |
|          | •                                          |            |                |
| IN       |                                            |            | 29             |
| IN       |                                            |            | S 4 1<br>C 1 4 |
| IN<br>IN |                                            | LIOW #     | 1              |
|          |                                            |            | _              |
| IN       |                                            | <b>"</b>   | 30             |
| IN<br>IN |                                            |            | S 4 2<br>C 1 5 |
| IN       | ·                                          | , 10W #    | 1              |
| IN       | 31 Interconnect ID number                  |            | 31             |
| IN       |                                            | ce row #   | S 5 1          |
| IN       |                                            |            | C 1 6          |
| IN       |                                            |            | 1              |
| IN       | 32 Interconnect ID number                  |            | 32             |
| IN       | 32 Source type(S,C, or F), Source ID, Sour | ce row #   | S 5 2          |
| IN       | 42 1                                       | row #      | C 1 7          |
| IN       | 32 Gain                                    |            | 1              |
| IN       | 33 Interconnect ID number                  |            | 33             |
| IN       | 33 Source type(S,C, or F), Source ID, Sour |            | S 5 3          |
| IN       | ·                                          | row #      | C 1 8          |
| IN       | 33 Gain                                    |            | 1              |
| IN       | 34 Interconnect ID number                  |            | 34             |
| IN       | == · · · · · · · · · · · · · · · · · ·     |            | S 6 1          |
| IN       | <b>==</b> :                                | row #      | C 1 9<br>1     |
| IN       | 34 Gain                                    |            | 1              |
| IN       | 35 Interconnect ID number                  |            | 35             |
| IN       | 35 Source type(S,C, or F), Source ID, Sour |            | S 7 1          |
| IN<br>IN | 35 Destination type(A or C), Dest ID, Dest | . LOW #    | C 1 10<br>1    |
| TIN      | 35 Gain                                    |            | -t-            |
| IN       | 36 Interconnect ID number                  |            | 36             |
| IN       | 36 Source type(S,C, or F), Source ID, Sour |            | S 8 1          |
| IN       |                                            | row #      | C 1 11         |
| IN       | 36 Gain                                    |            | 1              |
| IN       | 37 Interconnect ID number                  |            | 37             |
| IN       | 37 Source type(S,C, or F), Source ID, Sour |            | S 9 1          |
| IN       | 37 Destination type(A or C), Dest ID, Dest | row #      | C 1 12         |
|          |                                            |            |                |

| IN                   | 37 Gain                                                                                                        |                                 | 1                          |
|----------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------|
| IN<br>IN<br>IN       | · · · · · · · · · · · · · · · · · ·                                                                            |                                 | 38<br>S 10 1<br>C 2 1<br>1 |
| IN<br>IN<br>IN       |                                                                                                                | ID, Source row # ID, Dest row # | 39<br>S 10 2<br>C 2 2<br>1 |
| IN<br>IN<br>IN       |                                                                                                                |                                 | 40<br>s 10 3<br>c 2 3      |
| IN<br>IN<br>IN       | 41 Destination type(A or C), Dest                                                                              |                                 | 41<br>S 11 1<br>C 2 4<br>1 |
| IN<br>IN<br>IN       | 42 Source type(S,C, or F),Source<br>42 Destination type(A or C),Dest                                           |                                 | 42<br>S 11 2<br>C 2 5<br>1 |
| IN<br>IN<br>IN       | 43 Source type(S,C, or F), Source                                                                              |                                 | 43<br>S 11 3<br>C 2 6<br>1 |
| IN<br>IN<br>IN       | 17 Interconnect ID number<br>17 Source type(S,C, or F),Source<br>17 Destination type(A or C),Dest<br>17 Gain   |                                 | 17<br>C 2 1<br>A 26 1      |
| IN<br>IN<br>IN       | 18 Interconnect ID number<br>18 Source type(S,C, or F),Source<br>18 Destination type(A or C),Dest<br>18 Gain   |                                 | 18<br>C 2 2<br>A 27 1      |
| IN<br>IN<br>IN       | 19 Interconnect ID number<br>19 Source type(S.C. or F), Source<br>19 Destination type(A or C), Dest<br>19 Gain |                                 | 19<br>C 2 3<br>A 28 1      |
|                      | 20 Interconnect ID number<br>20 Source type(S,C, or F),Source<br>20 Destination type(A or C),Dest<br>20 Gain   | ID, Source row # ID, Dest row # | 20<br>C 2 4<br>A 23 1      |
| IN<br>IN<br>IN       | 21 Interconnect ID number<br>21 Source type(S,C, or F),Source<br>21 Destination type(A or C),Dest<br>21 Gain   | ID, Source row # ID, Dest row # | 21<br>C 2 5<br>A 24 1      |
| IN<br>IN<br>IN       | 22 Interconnect ID number<br>22 Source type(S,C, or F),Source<br>22 Destination type(A or C),Dest<br>22 Gain   |                                 | 22<br>C 2 6<br>A 25 1      |
| IN<br>IN<br>IN       | 23 Interconnect ID number<br>23 Source type(S,C, or F),Source<br>23 Destination type(A or C),Dest<br>23 Gain   |                                 | 23<br>S 17 1<br>C 1 13     |
| IN<br>IN<br>IN<br>IN | 24 Interconnect ID number<br>24 Source type(S,C, or F),Source<br>24 Destination type(A or C),Dest<br>24 Gain   |                                 | 24<br>S 17 2<br>C 1 14     |

| IN<br>IN<br>IN                         | <pre>25 Interconnect ID number 25 Source type(S,C, or F),Source ID,Source row # 25 Destination type(A or C),Dest ID,Dest row # 25 Gain</pre>                                                                                                                                                              | 25<br>S 17 3<br>C 1 15<br>1                            |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| IN<br>IN<br>IN                         | 44 Interconnect ID number<br>44 Source type(S,C, or F), Source ID, Source row #<br>44 Destination type(A or C), Dest ID, Dest row #<br>44 Gain                                                                                                                                                            | 44<br>S 17 4<br>C 1 16<br>1                            |
| IN<br>IN<br>IN                         | 45 Interconnect ID number<br>45 Source type(S,C, or F), Source ID, Source row #<br>45 Destination type(A or C), Dest ID, Dest row #<br>45 Gain                                                                                                                                                            | 45<br>S 17 5<br>C 1 17<br>1                            |
| IN<br>IN<br>IN                         | 46 Interconnect ID number<br>46 Source type(S,C, or F),Source ID,Source row #<br>46 Destination type(A or C),Dest ID,Dest row #<br>46 Gain                                                                                                                                                                | 46<br>S 17 6<br>C 1 18<br>1                            |
| IN<br>IN<br>IN                         | 47 Interconnect ID number 47 Source type(S,C, or F), Source ID, Source row # 47 Destination type(A or C), Dest ID, Dest row # 47 Gain                                                                                                                                                                     | 47<br>S 17 7<br>C 1 19<br>1                            |
| IN<br>IN<br>IN                         | 48 Interconnect ID number 48 Source type(S,C, or F), Source ID, Source row # 48 Destination type(A or C), Dest ID, Dest row # 48 Gain                                                                                                                                                                     | 48<br>S 17 8<br>C 1 20<br>1                            |
| IN<br>IN<br>IN                         | <pre>49 Interconnect ID number 49 Source type(S,C, or F),Source ID,Source row # 49 Destination type(A or C),Dest ID,Dest row # 49 Gain</pre>                                                                                                                                                              | 49<br>S 17 9<br>C 1 21<br>1                            |
|                                        | AEROD                                                                                                                                                                                                                                                                                                     |                                                        |
| AE<br>AE<br>AE<br>AE<br>AE<br>AE<br>AE | <pre>1 Aerodynamic Model ID # 1 Body ID, Center of Pressure Node ID 1 Atmosphere Type (C,J,M) 1 Constant Density for Atmosphere Type=C 1 Model Type (P,C,T,B) 1 Dimensions D,L (meters) 1 Unit Normal Vector x,y,z 1 Aero Ref Area, Ref Length (meters) 1 Name of Aero Coefficient Table Input File</pre> | 1<br>1 13<br>J<br>T<br>16.6051 2.2990<br>.\newttae.dat |
| AE<br>AE<br>AE                         | 1 Axial unit vector in body (alpha=0,phi=0) 1 Vert unit vector in body (alpha=90,phi=0) 1 Horiz unit vector in body (alpha=90,phi=90)                                                                                                                                                                     | 0. 0. 1.<br>.70717071 0.<br>.7071 .7071 0.             |

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